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The Physical Effects of Smoking

PRELIMINARY EXPERIMENTAL
STUDIES

By

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SEARCHES AND THEIR PRE-
SENTATION TO THE PUBLIC

15 37

INTRODUCTION

I have long felt that the influence of tobacco on physical and mental efficiency should receive careful scientific study. I therefore welcome the following essay, as representing important and almost pioneer work and hope that it will be followed by numerous physiological studies throughout the world.

The recent growth of the tobacco habit has been extremely rapid, especially since the cigarette has come into use. The great war has increased the use of tobacco, though it has decreased the use of alcohol. Women are beginning to smoke. A fashionable New York hotel has opened a special smoking room for women. Producers of cigarettes are advertising them more widely than ever before. In China, taking advantage of the elimination of the opium traffic, the producers of tobacco are making a special effort to substitute the tobacco habit.

While those who profit commercially by the sale of tobacco are thus seeking to increase the use of it, very little counter-influence has, as yet, been exerted. This has been partly due to indifference, but partly also to the fact that the ques-

tion of the harmfulness of tobacco has not been fully investigated.

It is a common opinion among medical men that smoking in "moderation" is harmless, or even beneficial. The public has a right to know whether this opinion is based on correct observations or is an unconscious concession to popular custom and prejudice.

The following essay would seem to indicate that smoking is more injurious than we have suspected. It will give pause to those who smoke or contemplate smoking, if they value their physical and mental alertness.

IRVING FISHER,
Yale University.

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FOREWORD

About four years ago I was giving a course of lectures on physical training and hygiene subjects at the Summer School of the Young Men's Christian Associations of the West at Estes Park, Colorado. In the course of one of my addresses I was asked several questions regarding the physical effects of smoking. I found the questions very difficult to answer, because there was so little reliable data available. Most of the material on this subject is based upon opinion and not upon research and is, therefore, not reliable. The fact that students who smoke in colleges are poorer in their studies than those who do not is not proof necessarily that smoking produces poor scholarship. There may be many other factors involved. I am sure there are. The same may be true of the delinquent boy who smokes. He is not necessarily delinquent because he smokes; he may smoke because he is delinquent. The fact of the matter is, very little research has been attempted. Upon making a statement of this character at the aforesaid place, I was approached by Mr. A. A. Hyde of Wichita, Kansas, a well-known philanthropist, who asked whether some

experiments of a scientific character could not be made really to determine, at least to some extent, what effect smoking had upon the heart and nervous system. He volunteered to stand the expense of such experiments.

I gave the matter considerable thought and tried to arrive at some method by which we could eliminate other factors and actually determine the effects of smoking on the physical organism.

A little later I came across a study made by Prof. Lombard, who stated that in making experiments upon himself he had discovered that the smoking of a single cigar had caused a rise in the heart rate. Following this Mr. B. D. Brink of Boston made an experiment on an individual and found the same result.

These experiments of course were too limited to be of value, but they gave direction to my thinking. In the summer of 1912, Mr. Elmer Berry and Mr. G. B. Affleck, of the faculty of the Eastern Young Men's Christian Association Summer School, made some physical tests of students attending the school, but we found our technique so faulty that we believed the results to be inaccurate and worthless.

I then requested Prof. Berry to elaborate the method, stating that I would take care of the expense, but I did not reveal the name of the individual who was furnishing the funds.

Mr. Berry and I worked out a method which we believed isolated the factor of smoking in its physical results, so that we could determine the physical effects. Mr. Berry describes this method elsewhere. After the first experiments, we were led to take up the subsequent ones. We are still continuing the work of experimentation. We hope to include tests to determine the effects of smoking upon endurance and upon mental concentration.

Our method may be open to considerable criticism. We have, however, tried to be honest in our attempts to get at actual facts. We are perfectly dispassionate in the matter. We have not tried in them to establish any preconceived idea of the effects of smoking. We are hunting for the truth. We would like to know what to say to young men, when they inquire of us what effect smoking will have upon them if they indulge themselves. Smoking has become an almost universal habit. It seems to be growing in extent. Furthermore, many men smoke a great many cigars in a day. A large number buy them by the box. We should surely know what the effects are of a habit which is so universal. If there are no bad effects then we need not, on physiological grounds, be concerned. On the other hand, if smoking is injurious we should surely know of it. This is the attitude taken

throughout these tests. Both smokers and non-smokers were used in the experiments. In the first and the last tests the students who directed the experiments were smokers. In the other tests they were non-smokers, so that any psychological influence was neutralized.

The results of the experiments were a surprise to all of us who had any part in them. I did not imagine that the smoking of a single cigar would have such demonstrable effect, especially in such general movements as are used in baseball pitching.

We do not, by any means, claim that these experiments are conclusive. They are not published as such. They are simply announced for what they are worth. They are presented as tentative and preliminary, and with the hope that others will repeat the experiments and announce their results.

Two things we would have the reader keep in mind. First, that these tests were made upon an exceptional group of men, mostly physical directors in more than the average physical condition and between the ages generally of 21 and 25 years. Perhaps if boys in the late teens had been used for experiment, or men of maturer years, the results would have been greater in degree. Perhaps, too, if men who were inveterate smokers had been tested, the evils would have

been shown to be greater. Furthermore, the room in which the experiments were made was well ventilated, which is unlike most of the conditions under which men smoke, and which if they had obtained might have accentuated the results.

In the second place, the results obtained were consistent in each of the four tests. This consistency is a considerable factor in emphasizing the results. It compels us to believe that smoking does affect the heart rate; does interfere with its return to the normal, delaying the process; and does affect neuro-muscular control. However, we wish the reader to come to his own conclusion after reviewing the tests.

If it is evident that the smoking of a single cigar interferes with an individual's efficiency, we believe that many men knowing this will greatly modify their habits—in fact, will give up smoking, which many have indulged in because they believed it to be physically beneficial; in fact, doctors have prescribed smoking because they have believed the results to be of value. We believe these experiments will stimulate many others to repeat them. This is our hope. We believe also that the results discovered should cause smokers to inquire carefully into their own experience and to act accordingly.

GEORGE J. FISHER, M.D.

GENERAL METHOD

The material here brought together represents an effort to secure definite experimental data regarding the effects of smoking. The original suggestion that such a series of experimental studies should be prosecuted came from Dr. George J. Fisher. The studies were made possible by Dr. Fisher through the interest and assistance of a friend.

The work has been done as graduation theses at the International Young Men's Christian Association College, Springfield, Mass., under the direction and general supervision of the writer. The entire theses, as presented by the students, bound in typewritten form, may be found in the library of the College. The material is published in its present form with the consent and approval of the faculty. The work here presented covers the researches conducted along this line during the years 1914-1916. Additional studies are now in process.

This material is presented entirely as preliminary and tentative work and with the idea of being suggestive and stimulative, rather than because of any belief that anything is as yet defi-

nitely proven. Many physical directors in Young Men's Christian Associations, schools, and colleges, and many physicians and physiologists are in a position to conduct such researches and secure evidence along similar or related lines. These studies should be repeated and verified or disproven by other observers. There is tremendous need of *definite facts* regarding the effects of smoking. A host of careful studies are needed to establish the fundamental truths underlying the whole problem.

While this work is preliminary and tentative and is offered rather because of its suggestive than its absolute value, nevertheless the writer believes that the results are reliable. Very little other definite experimental data is available on this subject, and it seems that the public should be put in possession of the material at hand. The work has been done in every case in a careful scientific spirit. Every effort has been made so to plan and conduct the experiments as to shut off all other influences except that of smoking. No preconceived theories were set up to be proven. Two of the studies were conducted by smokers—one of whom has since ceased to smoke because of the results which he secured—and two by non-smokers. The students undertook the studies rather expecting that no particular results would be shown, and they were assured

that such an outcome would be quite as satisfactory, so far as the thesis was concerned, as the most striking results either for or against smoking. The men who served as subjects were all normal, healthy, athletic fellows between the ages of 21 and 25, either non-smokers or moderate smokers. They, too, for the most part expected no results and were kept as far as possible in ignorance of the progress of the experiment. There was no incentive to beat anybody or anything. They gave their time to aid the investigation largely as a personal accommodation to the student who was conducting the study, and because of a general interest in the problem. Most of them were decidedly surprised and excited by the results of the experiments when they were made known.

A surprising feature is the remarkable uniformity and persistency of the results. The averages secured are not due to one or two big freak exceptions, but to the small, regular, persistent effects recorded by nearly every subject in almost every case. The individual tables for each study are given in an appendix following each part, largely so that this particular feature may be studied by those interested. It is one of the factors which give the writers the greatest confidence in the value and reliability of the studies.

The exact method of procedure is given for

each study in each part. For the purposes of these and similar studies a room was set aside in the third story of the gymnasium at the Young Men's Christian Association College at Springfield as a smoking laboratory. This was comfortably and cheerfully equipped with chairs, tables, etc., so that the subjects could read, write, or study while smoking. The scientific apparatus for making the desired tests was placed in this room. All of the studies so far have been conducted in the early evening after a light supper. The men came to the laboratory, went through the preliminary tests, smoked, repeated the tests and left. The willingness of the men to serve in this way is worthy of special commendation. All were students at the college. None of them would be classed as really heavy smokers. Interesting and valuable studies might be made of what the effects would be on men long accustomed to heavy smoking, on middle-aged business men, on young boys, and on those in poor condition of health, and also with different forms of tobacco (cigarette, cigar, pipe, etc.). The same brand of a strong cigar was used throughout these studies. A partial study, using cigarettes, was made in one case.

The studies are arranged in chronological order, as each was suggested by or grew out of the previous study. The general method of presenting

them is to state the objective and purpose of the thesis, give the conditions of the experiment and method of procedure, present one to three individual detailed tables as examples, then give the general average or summary tables, and follow with the final summary and conclusions. Following this appears an appendix, giving all of the detailed individual tables from which the average and summary tables were compiled. Throughout the book the letters A to M used in referring to the subjects of the experiments indicate non-smokers; the letters N to Z indicate smokers.

ELMER BERRY.

SUGGESTIONS TO THE READER

This book is intended both for popular reading and also for thorough study.

The material is so arranged that a general survey of each experiment can be quickly and readily made. It is also arranged so that those who would study the tests in careful detail have all the tables available for scrutiny.

The book is arranged in four parts. Each part contains the results of a special research. Each part in turn is presented in two sections, namely, a general statement with one or two typical tables and general summary, and an appendix containing a large number of tables giving the details in full. If the tables in the several appendices are passed over the first time, it will make the reading very simple and give a comprehensive survey of the studies. Then the tables can be returned to and studied in careful detail.

PART I

**THE EFFECTS OF SMOKING ON
HEART RATE AND BLOOD PRESSURE**

Experimental Work by

J. W. PAYNE

**International Young Men's Christian Association College,
Springfield, Mass., 1914**

I

THE EFFECTS OF SMOKING ON HEART RATE AND BLOOD PRESSURE

The object of this study was to determine the effect of smoking upon heart rate and blood pressure.

The room in which the tests were taken was the smoking laboratory previously mentioned, and while the conditions were not ideal, they did not vary from day to day.

The ventilation was direct and no effort was made to control the humidity. The temperature, however, was kept as nearly as possible at 68 degrees F.

The subjects were young men, leading active, healthy lives, none of them smoking oftener than twice each day, so that they may be classed as moderate smokers. They had supper at six P. M. and came to the room, which was a short distance from the dining hall, as soon as possible after they had eaten. In addition to walking this distance, there were two flights of stairs to climb, but if these were climbed in a leisurely manner, there was very little effect on the heart

4 PHYSICAL EFFECTS OF SMOKING

rate. If it was thought that a man had hurried, he was made to sit quietly, for a longer period than usual, or until conditions were normal.

Irrespective of the amount of exertion previous to entering the room, the subject was seated quietly for not less than five minutes. From where he was seated to where the horizontal tests were taken was not more than ten feet, but to obviate any effect which the rising from the chair, etc., might cause, he was allowed to lie for at least three minutes before the pulse rate was taken.

An ordinary watch having a second hand on the dial was used. The radial pulse was taken in the horizontal position, in three periods of a quarter second each, with a five-second interval between. Immediately after this the blood pressure was taken. The subject then rose to a standing position and time varying with the individual was allowed for cardiac adjustment. The pulse rate was again taken as in the horizontal position and this was followed by the blood pressure record.

The palpitation method was used to determine the blood pressure and the instrument used was a Stanton Sphygmomanometer, a modification of the Riva-Rocci instrument. Any change less than three millimeters was not considered. Pressure was applied until the pulse was obliterated

and then released, allowing the mercury to fall not more than 5 mm. at a time until the pulse reappeared. The mercury was again raised a few millimeters, obliterating the pulse, and lowered slowly until the pulse again reappeared and this reading was taken.

The so-called normal tests (i. e., without smoking) were taken to determine what effect the environment would have on the men.

To get this the heart rate and blood pressure were taken according to the procedure already described and again at the end of 30 minutes, and except for the fact that the men did not smoke every other condition was the same.

The subjects, whether smoking or not, were allowed to study, read, or write letters as they wished. It was observed, however, that more attention was given to the cigar than to the task they had set themselves and it is believed that the physical element did not enter into the tests to any great extent.

After smoking, the heart rate and blood pressure readings were taken again as before.

Illustrations of the individual tests on Mr. P. follow:

NORMAL TESTS (Without smoking)

Mr. P.

						Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/15	7:00	72	109	84	118				
	7:30	76	109	84	114	4	0	0	-4
II. 2/2	6:40	72	123	84	123				
	7:25	64	109	80	120	-8	-14	-4	-3
III. 2/5	7:05	80	111	96	117				
	7:40	72	109	80	111	-8	-2	-16	-6
IV. 2/6	7:15	80	101	92	105				
	7:50	72	100	88	110	-8	-1	-4	5
V. 2/11	7:40	76	106	84	108				
	8:15	66	105	76	107	-10	-1	-8	-1

CIGARETTE TESTS

Mr. P.

						Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/9	7:05	88	114	92	116				
	7:50	92	109	96	115	4	-5	4	-1
II. 2/12	7:10	76	114	88	116				
	7:55	76	115	88	117	0	1	0	1
III. 2/18	7:20	84	111	90	113				
	7:45	72	109	92	117	-12	-2	2	4
IV. 2/19	7:05	76	104	84	103				
	7:35	76	108	88	113	0	4	4	10
V. 2/25	7:10	76	106	88	109				
	7:40	80	110	88	113	4	4	0	4
VI. 3/2	7:15	80	108	100	110				
	7:45	76	104	92	106	-4	-4	-8	-4

CIGAR TESTS

Mr. P.

Date. Time		Difference							
		Hor.		Vert.		Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/22	7:00	80	112	94	117				
	7:40	88	112	96	124				
II. 1/26	7:00	84	106	88	113	8	0	2	7
	7:40	90	108	102	114	6	2	14	1
III. 1/30	7:20	72	103	84	114				
	8:00	72	108	84	110	0	5	0	-4
IV. 3/3	7:20	80	108	92	112				
	8:10	76	110	88	110	-4	2	-4	-2
V. 3/4	7:05	76	119	84	122				
	8:00	72	122	88	127	-4	3	4	5

The preceding results may be shown graphically by plotting the heart rate and blood pressure before and after smoking. For this purpose the average between the horizontal and vertical reading is taken as follows:

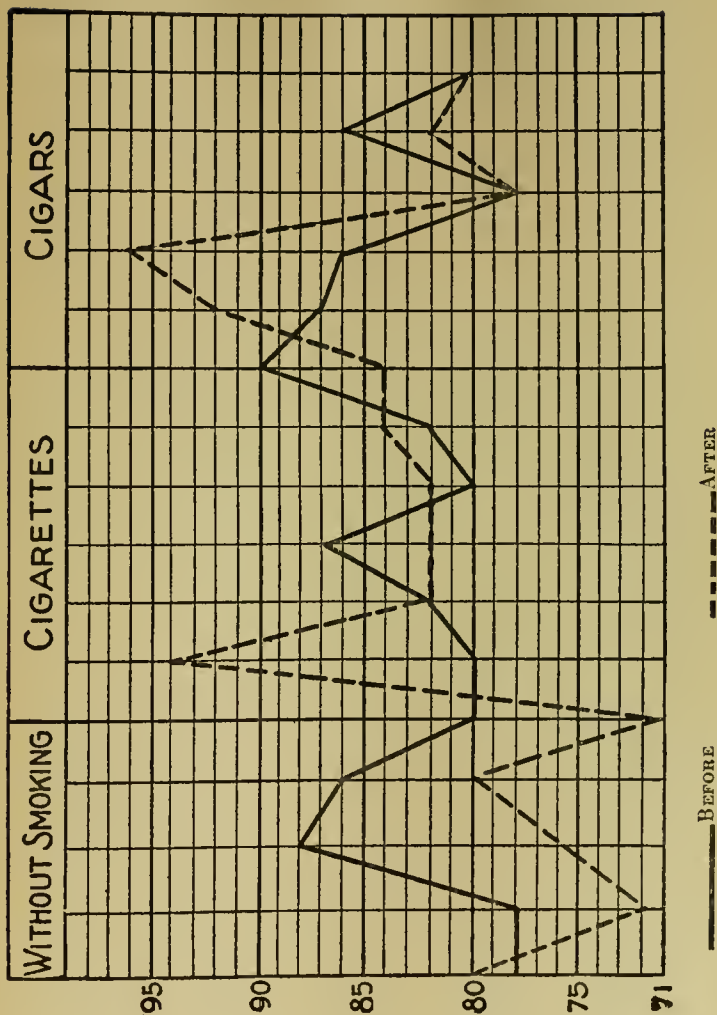
HEART RATE—MR. P.

	WITHOUT SMOKING					CIGARETTES					CIGARS				
	1/15	2/2	2/5	2/6	2/11	2/9	2/12	2/18	2/19	2/25	3/2	1/22	1/26	1/30	3/4
Date															
Before	78	78	88	86	80	80	82	87	80	82	90	87	86	78	80
After	80	72	76	80	71	94	82	82	82	84	84	92	96	78	80

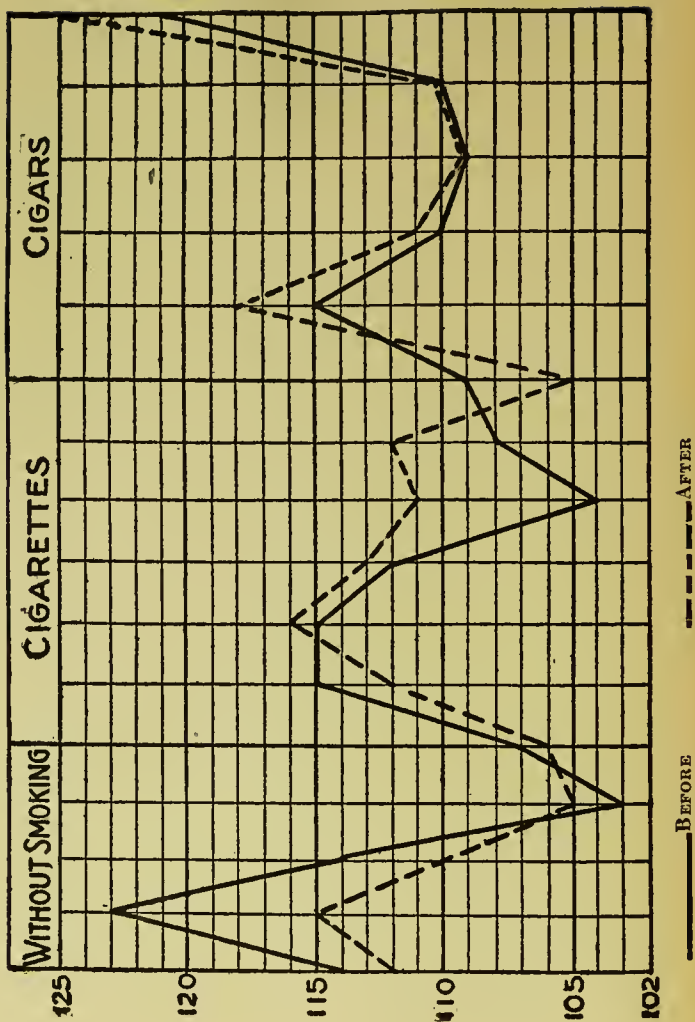
BLOOD PRESSURE—MR. P.

	WITHOUT SMOKING					CIGARETTES					CIGARS				
	1/15	2/2	2/5	2/6	2/11	2/9	2/12	2/18	2/19	2/25	3/2	1/22	1/26	3/30	3/4
Date															
Before	114	123	114	103	107	115	115	112	104	108	109	115	110	109	121
After	112	115	110	105	106	112	116	113	111	112	105	118	111	109	125

HEART RATE—MR. P.



BLOOD PRESSURE—MR. P.



The curves in the diagrams for Mr. P. show that under the conditions of the experiment without smoking there was a tendency for the heart rate and blood pressure to drop. With smoking the heart rate and blood pressure were generally raised.

Ten men were studied, 6 smokers and 4 non-smokers.

One hundred and nineteen experiments were made, 44 normal, 33 with cigarettes, and 42 with cigars.

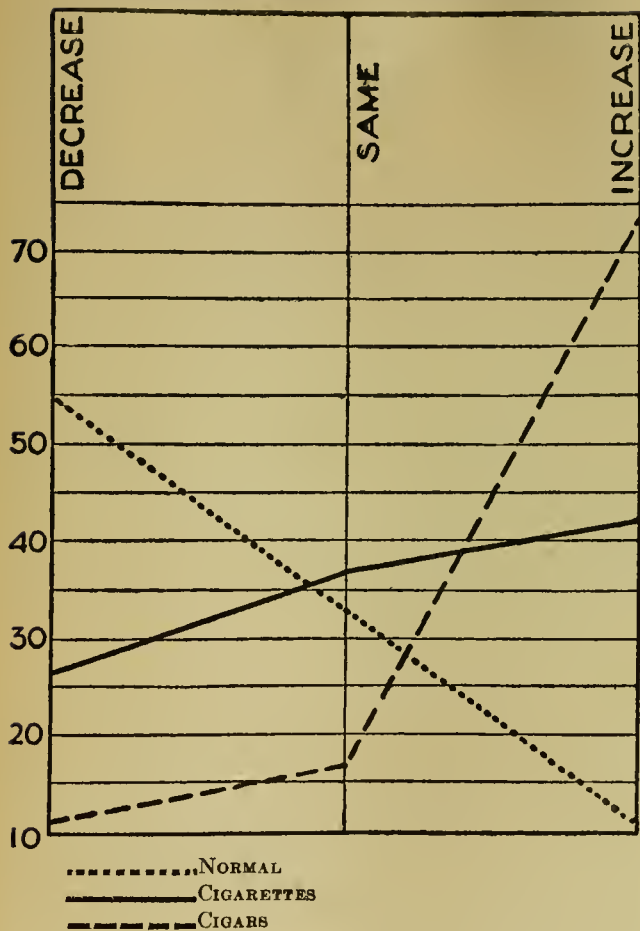
Observations on the change in heart rate and blood pressure were recorded 236 times, approximately half of them in the horizontal position and half in the vertical position. Of these 88 were normal, 64 with cigarettes and 84 with cigars.

A summary of all the tests follows which shows the number of times in which the heart rate and blood pressure increased, remained the same, or decreased, both in the horizontal and vertical positions and the per cent which each forms of the total number of observations. This is indicated for the normal individual where no smoking was done, after smoking cigarettes, and after smoking cigars.

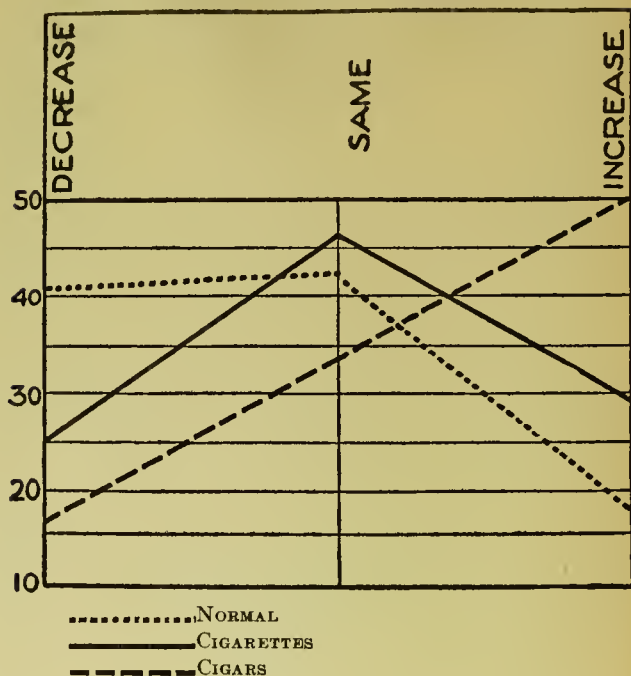
SUMMARY OF TABLES

	Normal				Cigarettes				Cigars			
HEART	Per				Per				Per			
RATE	Hor.	Vert.	Tot.	cent.	Hor.	Vert.	Tot.	cent.	Hor.	Vert.	Tot.	cent.
Decrease	23	25	48	54.5	8	6	14	21.8	4	5	9	10.7
Same	18	12	30	34.1	12	11	23	35.9	8	5	13	15.5
Increase	3	7	10	11.4	12	15	27	42.2	30	32	62	73.8
BLOOD												
PRESSURE												
Decrease	17	19	36	41	7	9	16	25	1	13	14	16.7
Same	21	16	37	42	16	14	30	46.9	12	16	28	33.3
Increase	6	9	15	17	9	9	18	28.1	29	13	42	50

PERCENTAGE OF CHANGE IN HEART RATE



PERCENTAGE OF CHANGE IN BLOOD PRESSURE



SUMMARY OF CONCLUSIONS

1. The conditions under which the normal tests (without smoking) were taken favored a decrease in heart rate and blood pressure. In heart rate 54.5 per cent decreased, 11.4 per cent increased. In blood pressure 41 per cent decreased, 17 per cent increased.

2. Some subjects were affected more than others.

3. Cigarette smoking caused an increase in heart rate and maintained a blood pressure which otherwise would have dropped.

4. Cigar smoking caused a considerable increase in heart rate and blood pressure.

5. In a number of instances in the cigar tests, the heart was unable to maintain in the vertical position the increased blood pressure found in the horizontal position, showing a disturbance of vaso-motor control.

6. The effect noted in conclusion 5 was more pronounced in tests taken on non-smokers.

In addition to these effects, there were some general impressions created, which are not stated in the conclusions from the tables of the tests. These impressions are given with a full realization that there are no figures from this study to substantiate them, and are as follows:

Before smoking, or during the tests taken to determine the effect of the environment, the time necessary for cardiac readjustment, as evidenced by the heart rate in changing from the recumbent to the vertical position, was usually from thirty to forty seconds. After smoking, it was often necessary to wait for a minute and a half or longer for the heart to resume its normal rhythm.

The reader should keep in mind in his summary of these experiments the following points:

1. The conditions under which the tests were taken favored a slowing down of the heart rate and a lowering of the blood pressure.

2. Instead of a slowing down, there was in most instances an actual increase in the heart rate and a rise in blood pressure.

3. Only a single cigar was used in each test. This should be kept in mind. It was surprising to find that such a minimum amount of smoking would reveal such measurable results.

4. The fact that the heart was not only accelerated, but took some considerable time to return to normal was significant—more so than that the heart simply rose in rate.

If a single cigar will disturb the rhythm of the heart to the extent that it will take some considerable time for it to return to the normal, then for a man to smoke several cigars a day would, in the course of a day, produce considerable disturbance in this important organic function.

It will pay the reader to read the detailed accounts of each experiment in the appendix to Part I, which follows.

INDIVIDUAL TABLES

For the reader who wishes to follow the first experiment in detail.

HEART RATE AND BLOOD PRESSURE 17

APPENDIX TO PART I

NORMAL TESTS (Without Smoking) Mr. P.

		Hor.		Vert.		Difference			
Date Time		H.R.	B.P.	H.R.	B.P.	Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/15	7:00	72	109	84	118				
	7:30	76	109	84	114	4	0	0	-4
II. 2/2	6:40	72	123	84	123				
	7:25	64	109	80	120	-8	-14	-4	-3
III. 2/5	7:05	80	111	96	117				
	7:40	72	109	80	111	-8	-2	-16	-6
IV. 2/6	7:15	80	101	92	105				
	7:50	72	100	88	110	-8	-1	-4	5
V. 2/11	7:40	76	106	84	108				
	8:15	66	105	76	107	-10	-1	-8	-1

CIGARETTE TESTS Mr. P.

		Hor.		Vert.		Difference			
Date Time		H.R.	B.P.	H.R.	B.P.	Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/9	7:05	88	114	92	116				
	7:50	92	109	96	115	4	-5	4	-1
II. 2/12	7:10	76	114	88	116				
	7:55	76	115	88	117	0	1	0	1
III. 2/18	7:20	84	111	90	113				
	7:45	72	109	92	117	-12	-2	2	4
IV. 2/19	7:05	76	104	84	103				
	7:35	76	108	88	113	0	4	4	10
V. 2/25	7:10	76	106	88	109				
	7:40	80	110	88	113	4	4	0	4
VI. 3/2	7:15	80	108	100	110				
	7:45	76	104	92	106	-4	-4	-8	-4

CIGAR TESTS Mr. P.

		Hor.		Vert.		Difference			
Date Time		H.R.	B.P.	H.R.	B.P.	Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/22	7:00	80	112	94	117				
	7:40	88	112	96	124	8	0	2	7
II. 1/26	7:00	84	106	88	113				
	7:40	90	108	102	114	6	2	14	1
III. 1/3	7:20	72	103	84	114				
	8:00	72	108	84	110	0	5	0	-4
IV. 3/3	7:20	80	108	92	112				
	8:10	76	110	88	110	-4	2	-4	-2
V. 3/4	7:05	76	119	84	122				
	8:00	72	122	88	127	-4	3	4	5

CONCLUSIONS FROM TESTS TAKEN ON MR. P.

The heart rate of this subject is higher than is usually found in the men here. The blood pressure, however, is well within the normal range.

Apparently the conditions under which the tests were conducted did not affect the subject. In only one experiment, 1/15, did the heart rate increase and the same is true of the blood pressure, there being a rise of 5 mm. of Hg. in experiment 2/6. With these two exceptions, there is a uniform drop in both heart rate and blood pressure.

In the tests taken to determine the effect of cigarette smoking, the heart rate in the horizontal position shows a rise in two experiments, a drop in two, and in two it remained the same after smoking as before. The greatest change occurred in experiment 2/18. Here the heart decreased 12 beats per minute after smoking. This decrease might be taken as an indication of the soothing effect of tobacco smoking, but the range in heart rate between the horizontal and vertical positions is more likely to be an indication of cardiac disturbance. There is a possibility, however, that the fatigued condition of the subject had something to do with the change. In the vertical position, there is a more general tendency of the heart rate to increase except in test 3/2, in

which it will be noticed that the heart rate before smoking was exceptionally high.

In the horizontal position, the blood pressure shows an increase in three readings and a decrease in three readings. These gains, or losses, however, do not exceed 5 mm. In the vertical position, there is a decrease in but one experiment, 3/2, the other records showing at least the same if not an increased blood pressure after smoking.

In view of these tests, there seems to be little cause for alarm over the moderate use of cigarettes, as far as heart rate and blood pressure is concerned, and the most that can be said in conclusion is that the smoking in a number of cases maintained a heart rate and blood pressure that otherwise would have fallen.

Cigars affected the subject but little more than the cigarette. The decrease in heart rates in both horizontal and vertical positions is slight, but the rise, where there is one, is more decided and the same is true of the blood pressure. However, the number of negative changes is smaller than was found when cigarettes were used, and it does not seem to be an exaggeration to say that cigar smoking caused a slight increase in heart rate and blood pressure.

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NORMAL TEST

Mr. R.

Date Time		Hor.		Vert.		Difference			
		Hor.		Vert.		Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/15	7:00	60	113	68	122				
	7:30	60	119	76	123	0	6	8	1
II. 2/12	7:45	72	123	92	119				
	8:15	68	101	84	105	-4	-22	-8	-14
III. 2/16	7:10	72	123	88	118				
	7:40	60	112	88	111	-12	-11	0	-7

CIGARETTE TEST

Mr. R.

Date Time		Hor.		Vert.		Difference			
		Hor.		Vert.		Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/8	6:55	50	128	60	135				
	7:30	68	129	72	128	12	1	12	-7
II. 2/11	7:30	72	122	80	122				
	8:05	68	119	84	120	-4	-3	4	-2
III. 2/13	3:00	64	122	84	124				
	3:30	70	123	92	128	6	1	8	4
IV. 2/20	6:40	60	119	84	114				
	7:20	64	119	84	116	4	0	0	2
V. 2/25	6:30	*64	125	80	123				
	7:05	72	140	88	135	8	15	8	12

* Three cigarettes.

CIGAR TEST

Mr. R.

Date Time		Hor.		Vert.		Difference			
		Hor.		Vert.		Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/21	8:10	62	116	72	115				
	9:00	62	123	76	122	0	7	4	7
II. 1/23	7:00	64	133	92	129				
	7:40	72	134	88	123	8	1	-4	-6
III. 1/28	7:45	72	134	88	124				
	8:25	72	133	88	125	0	-1	0	1
IV. 3/4	6:40	60	123	76	121				
	7:20	72	127	80	123	4	4	4	2

CONCLUSIONS FROM TESTS TAKEN ON MR. R.

Mr. R. could not give the time necessary for the completion of the tests and they are unsatisfactory on that account. The first experiment, 1/15, was taken the first time the subject came to the room and he was, therefore, not used to the conditions. The rise in heart rate and blood pressure could very easily be attributed to some exciting factor, though a careful consideration failed to reveal anything out of the ordinary.

In the other two tests there is a decided decrease in both heart and blood pressure, except in test 2/16, in which case the heart rate in the vertical position remained the same. In view of the decided change in these two tests, it is fair to say that the heart rate and blood pressure dropped.

The cigarette tests show a general increase in heart rate, except in test 2/11, in which there was a decrease of 4 beats per min. in the horizontal position, and in test 2/20 it remained the same in the vertical position.

However, the increase of over four beats in almost every other instance proves that cigarette smoking caused the heart rate to increase.

The blood pressure shows no great changes. In test 2/8 the increase in heart rate and the change of seven in pressure between the vertical

and the horizontal positions before smoking, as contrasted with a lack of change after smoking, might be considered an indication of loss of vasomotor control. In test 2/25 the subject smoked three cigarettes and the result shows that the effect was much greater. From this it would seem that only the smoking of a third cigarette would produce definite changes.

The general effect on this subject seems to be to increase the heart rate and maintain a blood pressure which would otherwise have decreased.

Smoking a cigar apparently did not affect this subject as much as cigarette smoking. This in all probability is due to the fact that the subject inhaled in the latter case and this would permit of greater toxic effects.

According to Dr. Crampton, the blood pressure indicates poor condition, inasmuch as the pressure in the vertical position is less than in the horizontal position. There is little proof that this poor condition is accelerated to any extent by the smoking of a cigar. In test 1/23 the heart rate is brought to a more nearly normal condition, but the blood pressure condition is aggravated and this is also true in test 3/4. However, in test 1/28 the condition is improved. This is not enough evidence to prove that smoking is either beneficial or harmful in this sense.

The survey of the cigar tests fails to bring out

any striking changes. In only one case did the blood pressure show a marked decrease and in that test it also showed a striking decrease in the pressure change between the horizontal and vertical position. The indication here is that the vaso-motor control is affected. Apart from this, the heart rate and blood pressure were maintained, but the effect of tobacco smoking in this, as in all the other tests, should be measured in terms of the decrease which would have been present if the subject had not smoked.

NORMAL TESTS

Date	Time	Mr. S.				Difference			
		Hor.		Vert.		Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/22	7:00	72	122	84	123				
	7:30	72	118	76	115	0	-4	-8	-8
II. 2/2	7:00	80	133	88	135				
	7:30	76	134	88	138	-4	1	0	3
III. 2/5	6:40	80	112	88	116				
	7:20	78	110	80	110	-2	-2	-8	-6
IV. 2/11	7:45	76	126	88	122				
	8:20	76	120	80	121	0	-6	-8	-1
V. 4/7	8:05	76	119	88	122				
	8:35	76	120	80	120	0	1	-8	-2

CIGARETTE TESTS

Date	Time	Mr. S.				Difference			
		Hor.		Vert.		Hor.		Vert.	
		H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/9	7:25	76	125	96	127				
	8:00	76	119	96	121	0	-6	0	-6
II. 2/11	8:15	76	120	78	121				
	8:40	76	121	84	117	0	1	6	-4
III. 2/12	7:15	76	119	92	125				
	7:40	72	113	86	113	-4	-6	-6	-12
IV. 2/17	7:30	76	114	92	111				
	8:00	72	115	88	116	-4	1	-4	5
V. 2/19	7:30	76	124	92	124				
	8:05	76	132	92	128	0	8	0	4

		CIGAR TEST							
		Mr. S.				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/15	7:00	60	113	68	122				
	7:40	60	119	76	123	0	6	8	1
II. 1/18	2:45	72	114	80	122				
	3:30	76	114	88	122	4	0	8	0
III. 1/19	7:25	72	116	80	116				
	8:05	76	122	80	127	4	6	0	11
IV. 1/22	7:40	72	118	76	115				
	8:25	72	131	72	127	0	13	-4	12
V. 1/26	7:05	76	123	82	125				
	7:50	76	129	94	126	0	6	12	1
VI. 1/27	6:45	74	128	84	125				
	7:05	78	132	94	126	4	4	10	1
VII. 1/29	7:00	68	130	80	124				
	7:40	76	130	84	127	8	0	4	3

CONCLUSIONS FROM TESTS TAKEN ON MR. S.

The heart rate in the horizontal position remained the same or was slightly lower. In the vertical position there is a more decided change. In only one instance, test 2/2, was the heart rate the same, a uniform decrease of eight beats being the result in the other tests.

In the test in which the heart rate remained the same, there was a slight increase in the blood pressure in the vertical position. With this exception, the pressure was decreased or the same. The burden of the tests then would be to prove that under the conditions of the test the heart rate and blood pressure would decrease.

The results of the cigarette tests are not defi-

nite in showing either a beneficial or deleterious effect. While it is true that the negative results are not as frequent as in the normal tests and that in tests 2/11 and 2/19 the blood pressure condition is slightly changed, it might be argued from tests 2/12 and 2/17 that the effect really improved the subject's condition, since in the first test both heart rate and blood pressure were materially reduced and in the latter case the condition was more nearly normal. In view of these facts, it may be said that the cigarette smoking did not affect the smoker.

In the tests taken to determine the effects of a single cigar, there is a record of but one decrease, and that of four beats per minute in the heart rate in the vertical position, test 1/22. In a few cases, the heart rate remained the same, but the greater number of records show a definite increase.

The blood pressure records show that there were no negative changes, the pressure remaining the same in six tests and showing a rise of from 3mm. to 13mm. of Hg. in eight.

The relative changes, i. e., the difference between heart rate and blood pressure in the horizontal and vertical positions, remained practically unchanged after smoking.

It is evident that although there were no abnormal conditions resulting from smoking a cigar,

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there is a tendency on the part of the heart rate and blood pressure to increase.

NORMAL TESTS Mr. T.

Date	Time	Hor.		Vert.		Difference			
		H.R.	B.P.	H.R.	B.P.	Hor.		Vert.	
I. 2/2	7:05	62	105	88	110	0	-1	-8	4
	7:35	62	104	80	114				
II. 2/11	7:25	64	110	80	115	-8	-3	-12	-5
	8:00	56	107	68	110				
III. 4/6	7:25	68	114	84	114	0	0	-4	2
	8:00	68	114	80	116				
IV. 4/9	7:15	68	106	88	108	0	2	0	4
	7:55	68	108	88	112				
V. 4/13	7:25	72	114	88	115	-4	-2	-8	-1
	8:10	68	112	80	114				

CIGAR TESTS Mr. T.

Date	Time	Hor.		Vert.		Difference			
		H.R.	B.P.	H.R.	B.P.	Hor.		Vert.	
I. 1/18	7:30	64	108	88	114	10	6	0	6
	8:10	74	114	88	120				
II. 1/19	8:00	64	109	92	119	4	2	4	1
	8:45	68	111	96	120				
III. 1/20	8:30	66	109	88	117	4	0	-8	-5
	9:10	70	109	80	112				
IV. 1/21	7:30	68	110	84	122	4	-1	4	-5
	8:15	72	109	88	117				
V. 4/6	7:20	68	113	84	116	4	0	8	-1
	8:15	72	113	92	115				

CONCLUSIONS FROM TESTS TAKEN ON MR. T.

A study of the normal tests taken on Mr. T. shows a decided drop, or at least a maintenance of a fairly low heart rate.

The blood pressure was maintained in the hori-

zontal position, except in one case in which there was a slight decrease. In the vertical position the blood pressure increased in two experiments, was maintained in two and decreased in one. It is, therefore, the conclusion that there is a slight tendency of the blood pressure to rise. The changes are so slight as to be almost negligible and the most that can be said is that there is a slight drop in the heart rate.

The odor and taste of a cigarette were objectionable and it was possible to secure but one test, which is given here.

		Difference							
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
3/4	7:30	72	102	84	105				
	8:05	68	115	88	117	-4	13	4	12

According to this, there is a decided increase in blood pressure, but the effect on the heart rate is of no account. The change in the blood pressure may be due to the cigarette smoke, but a part of it is probably due to the psychological disturbance, since the subject made known his dislike for this form of smoking during the entire period.

While the cigar tests show no alarming changes, the action of the heart is at least definite in its increase, except in test 1/18, in which it

remained the same and in test 1/20 in which there was a decrease of 8 beats per min. In this latter case, however, the heart was irregular in its rhythm when the subject assumed the vertical position, and this would militate against the use of tobacco by this subject.

The blood pressure in the horizontal position was maintained except in one case, 1/18, in which it was increased. In the vertical position in this same test there was also an increase. In two tests there was a decrease in blood pressure in the vertical position and in the remaining two tests it remained as before smoking.

The conclusion is that cardiac and vaso-motor control were disturbed to a slight degree by smoking.

NORMAL TESTS

Mr. U.

						Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/20	7:25	76	118	96	116				
	7:55	70	122	96	119	-6	4	0	3
II. 3/2	7:00	*80	130	100	116				
	7:30	72	127	100	122	-8	-3	0	6
III. 4/7	7:15	76	135	92	128				
	7:55	76	135	88	137	0	0	-4	9
IV. 4/9	7:25	76	130	88	126				
		80	129	88	123	4	-1	0	-3
V. 4/14	7:30	†76	129	92	125				
		72	124	84	127	-4	-5	-8	2

* Bad cold.

† Indigestion.

HEART RATE AND BLOOD PRESSURE 29

CIGARETTE TESTS

		Mr. U.				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/12	7:30	76	131	98	123				
	8:00	76	126	96	117	0	-5	-2	-5
II. 2/14	7:00	84	120	88	123				
	7:25	80	123	100	128	-4	3	12	5
III. 2/25	7:15	88	124	100	120				
	7:45	88	132	100	122	0	8	0	2
IV. 3/4	6:40	76	127	96	119				
	7:20	76	127	100	118	0	0	4	-1
V. 3/30	7:05	*76	134	100	130				
	7:45	72	132	100	124	-4	-2	0	-6

* Three cigarettes.

CIGAR TESTS

		Mr. U.				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 3/31	7:10	84	129	110	130				
	8:10	80	116	108	116	-4	-13	-2	-14
II. 4/3	6:35	84	124	100	124				
	7:05	88	136	112	130	4	12	12	6
III. 4/6	3:05	76	128	88	125				
	4:10	68	128	88	125	-8	0	0	0
IV. 4/8	6:55	80	129	100	122				
	7:40	92	135	108	116	12	6	8	-6
V. 4/13	7:05	76	130	88	129				
	7:55	76	140	96	128	0	10	8	-1

CONCLUSIONS FROM TESTS TAKEN ON MR. U.

A study of the normal tables of Mr. U. shows that the heart rate remained the same or decreased, except in one instance in which there was an increase of 4 beats per min. in the horizontal position. It will be noticed, however, that the heart rate in the vertical position is higher than

is usually found in men who are taking regular exercise.

The blood pressure shows that the man, according to Dr. Crampton, was in poor condition, although he laughed at the suggestion.

In the horizontal position there is a slight drop in two tests, a rise in one and no change in the remaining two. In the vertical position there is a rise in three tests, a drop in one and no change in one. The evidence, therefore, would seem to be in favor of a slight rise in blood pressure in the vertical position.

A close study of the table reveals the fact that the heart rate is extremely high, with a difference of 20 beats or over between the horizontal and vertical, except in test 4/9, where there is a difference of 12. A second fact to be observed is that the blood pressure in every instance was lower in the vertical than in the horizontal position when the first tests were taken. The tests taken at the end of the rest period show a change in condition for the better: in two the relative difference was the same and in one the fault was accentuated.

The heart rate shows an improvement in cardiac control in three tests and in two it is aggravated, because of a lower rate in the horizontal position.

While there was not a uniformity in the

changes, there does not seem to be evidence enough to warrant a belief that the test conditions affected the subject unfavorably.

The tests taken after the subject had smoked the required number of cigarettes, when compared with the results before smoking, show no changes that, taken as a group, can be used to prove anything one way or another. The relative differences, however, show changes that give one a clearer idea of the effects.

In the normal tests the balance of the results was in favor of an improved condition, but in this table the opposite is true. In every instance in which the blood pressure was lower in the vertical than in the horizontal position the range was increased. The heart rate was affected in the same way in two instances, and in the three remaining tests there was no change in the relation. In view of these facts, it may be said that cigarette smoking affected the subject unfavorably in that there was a slight loss of vaso-motor control.

The changes that take place after the subject had smoked a cigar are more decided than in either the normal or cigarette tests, but they are not at all uniform. It will be necessary, therefore, to consider each test on its own merit.

In test 3/31 the blood pressure has been reduced to a more nearly normal level, but an ex-

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tremely high heart rate was not appreciably affected.

In test 4/3, an already high heart rate is increased. The blood pressure is also increased and in addition the relation between the horizontal and vertical is disturbed.

Test 4/6 shows no change except a decreased heart rate in the horizontal position.

The next experiment, 4/8, shows a considerable increase in heart rate. The blood pressure in the recumbent position is also increased, but there is a decrease in the vertical position. These results point to a loss of vaso-motor control.

Test 4/13 is practically the same as the preceding one and although the blood pressure in the horizontal position borders on the abnormal, the relative difference is not quite as great.

It is evident from these results that cigar smoking caused a loss of vaso-motor control.

		NORMAL TESTS							
		Mr. V.				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/21	7:00	68	123	80	133				
	7:30	68	123	84	131	0	0	4	-2
II. 2/5	6:55	68	129	80	130				
	7:30	68	123	84	125	0	-6	4	-5
III. 4/8	7:25	76	122	84	124				
	8:00	76	127	84	128	0	5	0	4
IV. 4/14	7:25	68	123	84	125				
	7:55	68	121	76	127	0	-2	-8	2
V. 4/16	6:55	72	120	80	129				
	7:25	76	128	80	128	4	8	0	-1

HEART RATE AND BLOOD PRESSURE 33

CIGARETTE TESTS

		Mr. V.				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/12	6:45	*76	127	88	136				
	7:30	86	130	104	138	10	3	16	2
II. 2/18	7:00	68	118	80	125				
	7:30	76	122	92	124	8	4	12	-1
III. 2/20	7:15	76	115	80	117				
	7:45	72	113	92	116	-4	-2	12	-1
IV. 2/21	7:45	72	123	84	123				
	8:15	76	122	88	125	4	-1	4	2
V. 4/5	7:05	*76	131	84	134				
	7:40	80	129	92	124	4	-2	8	-10

* Three cigarettes.

CIGAR TESTS

		Mr. V.				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 1/20	7:00	68	123	84	132				
	7:40	88	136	108	146	20	13	24	14
II. 1/21	7:30	68	123	84	131				
	8:10	84	134	92	142	16	11	8	11
III. 1/22	7:10	72	129	78	132				
	7:55	84	139	96	132	12	10	18	0
IV. 1/23	6:45	72	118	84	126				
	7:30	90	129	100	132	12	11	16	6
V. 4/3	7:30	80	129	88	130				
	8:20	88	132	96	133	8	4	8	3

CONCLUSIONS FROM TESTS ON MR. V.

In considering the results of these tables, it should be kept in mind that this man apparently was able to concentrate on the work which he had elected to do while he was in the room. Despite the psychological stimulus which was undoubtedly present, there are not enough increases in either heart rate or blood pressure to permit the statement that the conditions affected him unfavorably.

The cigarette tests are consistent in the action on the heart, which is increased in every instance except in test 2/20, in which there was a decrease of 4 beats, but in this case the relative change should be considered.

The blood pressure was hardly affected and the most that one can say is that the blood pressure was maintained. In the preceding statement, test 4/5 was purposely left out of the consideration, because in this case as in test 2/12, three cigarettes were smoked. The effect in test 2/12 was to increase the heart rate greatly. In test 4/5 the effect is on both the heart rate and blood pressure, increasing the former and disturbing the balance in the latter.

The effect then of cigarette smoking, plus a psychical element, not measurable, is to increase the heart rate, and once where three cigarettes are smoked, to disturb the vaso-motor control.

The cigar smoking, on the other hand, made a most decided impression. The heart rate increased as many as twenty-four beats and the blood pressure, except in one instance, registered an increase in arterial pressure. In the one instance mentioned, test III, there was no change in the vertical pressures before and after smoking. However, it will be observed that the heart was unable to maintain the high pressure found in the horizontal position.

HEART RATE AND BLOOD PRESSURE 35

The conclusion from these experiments is that the heart rate is increased slightly from cigarette smoking and both blood pressure and heart rate are materially increased when a cigar is smoked.

NORMAL TESTS Mr. A.—Non-Smoker

						Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 2/9	7:00	64	123	72	119				
	7:50	60	117	88	115	-4	-6	16	-4
II. 2/17	7:10	68	130	96	125				
	7:40	68	117	88	111	0	-13	-8	-14
III. 2/18	7:30	68	114	88	112				
	8:00	68	115	88	113	0	1	0	1
IV. 3/3	7:35	68	124	80	122				
	8:05	64	117	88	115	-4	-7	8	-7

SMOKING TESTS—CIGAR Mr. A.

						Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 3/30	7:20	*76	116	88	116				
	7:55	88	123	96	119	8	7	8	3
II. 3/31	7:20	72	110	84	120				
	8:00	80	120	96	116	8	10	12	-14
III. 4/6	7:00	*76	118	88	114				
	7:40	84	124	100	104	8	6	12	-10
IV. 4/7	7:05	*60	118	84	120				
	7:50	72	126	92	110	12	8	8	-10
V. 4/13	7:00	*80	122	88	122				
	8:05	80	128	96	116	0	6	8	-6

* Headache after smoking.

CONCLUSIONS FROM TESTS TAKEN ON MR. A.

The normal tests of Mr. A., a non-smoker, show two rises of heart rate which cannot be accounted for, otherwise the heart rate was decreased.

Except in the test taken on 2/17, in which it did not change, the blood pressure decreased.

The smoking of a single cigar caused the heart rate to increase in all except in the horizontal position in test 4/13. The blood pressure in the horizontal position increased from 6 to 10 mm. of Hg., but the heart was unable to maintain the rise in the vertical position, with the result that there is not only a decrease in the blood pressure in the vertical position, as compared with the horizontal position, but also it is lower than the pressure in the vertical position before smoking, except in test 3/30. This proves conclusively that there was a loss of vaso-motor control.

In addition to the heart rate and blood pressure changes registered in the tables, it is proper that mention should be made of the fact that the subject suffered from a headache which lasted the greater part of the evening.

NORMAL TESTS
Mr. B.—Non-Smoker

						Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 3/31	7:15	76	114	88	110				
	7:50	76	112	92	110	0	-2	4	0
II. 4/1	6:55	70	115	88	115				
	7:45	70	110	84	111	0	-5	-4	-4
III. 4/3	7:40	*76	110	92	114				
	8:15	68	116	88	109	-8	6	-4	-5
IV. 4/7	7:10	80	122	92	124				
	7:40	76	124	88	124	-4	2	-4	0

* Cold in head.

HEART RATE AND BLOOD PRESSURE 37

CIGAR TESTS

Mr. B.

	Date	Time	Mr. B.				Difference			
			Hor.		Vert.		Hor.		Vert.	
			H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I.	4/6	3:45	76	122	88	117				
		4:40	80	131	100	116	4	9	12	-1
II.	4/14	7:00	72	120	96	121				
		7:40	88	133	104	123	10	13	8	2
III.	4/15	7:15	76	122	96	124				
		8:05	88	126	108	116	12	4	12	-8
IV.	4/16	6:45	80	121	88	122				
		7:20	88	129	104	124	8	8	16	2

CONCLUSIONS FROM TESTS TAKEN ON MR. B.

The normal chart of Mr. B. shows a general decrease in heart rate and blood pressure. In the third test of this series the subject complained of having a cold, which may account for the results shown here. In view of this fact, it may be well to leave this record out of the consideration.

The result of the tests taken during the smoking period show results similar to, but not as severe as those of Mr. A. The effect on the heart was to accelerate an already high rate, and in the horizontal position the blood pressure shows an increase. In the vertical position the blood pressure is the same or lower after smoking.

Comparing the blood pressure in the vertical position with the blood pressure in the horizontal, it is found that there is a decided drop, the greatest being 16mm. in the first test, which was taken on the afternoon of April 6th, soon after dinner.

If the deduction used throughout this test—that there is a lower blood pressure in the vertical position than in the horizontal—be true, the effect of smoking was to aggravate an already poor condition.

In all the tests the increase in heart rate and the lower pressure in the vertical than in the horizontal position, would argue that there was a loss of vaso-motor control.

This subject felt no ill effects from the smoking.

		NORMAL TESTS							
		Mr. C.—Non-Smoker				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 3/31	7:10	60	114	76	114				
	7:40	56	112	76	116	-4	-2	0	2
II. 4/2	7:10	64	111	72	113				
	7:40	60	110	64	109	-4	-1	-8	-4
III. 4/3	7:35	64	115	76	114				
	8:10	60	112	76	115	-4	-3	0	1
IV. 4/6	4:10	60	115	76	114				
	4:40	60	111	88	110	0	-4	12	-4

		SMOKING TESTS							
		Mr. C.—Non-Smoker				Difference			
		Hor.		Vert.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 4/6	7:35	*68	113	84	114				
	8:30	72	116	92	105	4	3	8	-9
II. 4/9	7:05	†68	116	84	110				
	7:35	72	119	84	109	4	3	0	-1
III. 4/13	7:15	‡64	114	84	118				
	7:55	64	111	84	112	0	-3	0	-6
IV. 4/15	7:40	‡64	118	88	120				
	8:10	64	116	80	127	0	-2	-8	7

* One cigar.

† Two cigarettes.

‡ Three cigarettes.

CONCLUSIONS FROM TESTS TAKEN ON MR. C.

Mr. C.'s blood pressure and heart rate remained the same or decreased during the time he stayed in the room but did not smoke. I cannot account for the increase in heart rate in the vertical position, test 4/6, unless perhaps it was due to the subject having to stand for a longer period than was usual, while I was opening the door of the room to admit another subject.

The first cigar this subject smoked so nauseated him that he refused to continue the tests unless he was permitted to smoke the milder cigarette, and for this reason a complete series of cigar tests could not be obtained.

The one test taken, in which the subject smoked a cigar, shows all the characteristics of a dilation of the vessels of the splanchnic area, viz. : increased heart rate, horizontal and vertical, and increased blood pressure in the horizontal position, followed by a sharp drop in pressure on resuming the vertical position. The sum of the result is that there was a loss of vaso-motor control.

The cigarettes apparently did not affect the subject to a noticeable extent, except to cause a slight headache.

In discussing this thesis with this subject, some time after the tests were taken, he remarked

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that the tests should have been taken again, within an hour after he had left the experiment room. Apparently the full effects did not take place until some time after he had stopped smoking.

NORMAL TESTS Mr. D.—Non-Smoker

		Hor.		Vert.		Difference			
		H.R.		B.P.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 3/30	7:10	72	122	84	120				
	7:45	68	120	88	115	-4	-2	4	-5
II. 4/2	7:15	68	123	80	119				
	7:45	60	116	76	117	-8	-7	-4	-2
III. 4/3	7:00	64	122	80	120				
	7:45	60	118	68	111	-4	-4	-12	-9
IV. 4/6	3:35	60	114	84	114				
	4:20	60	120	84	118	0	6	0	4

SMOKING TESTS Mr. D.—Non-Smoker

		Hor.		Vert.		Difference			
		H.R.		B.P.		Hor.		Vert.	
Date	Time	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.	H.R.	B.P.
I. 4/6	7:40	*76	124	92	120				
	8:25	84	131	100	116	8	7	8	-4
II. 4/9	7:10	†76	120	92	116				
	7:40	84	120	96	118	8	0	4	2
III. 4/15	7:20	†68	123	88	126				
	7:55	68	124	88	124	0	1	0	-2
IV. 4/16	6:25	†64	124	76	127				
	6:40	64	122	76	128	0	-2	0	1

* One cigar. Nauseated-headache.

† Three cigarettes.

‡ Two cigarettes. Nauseated-headache.

CONCLUSIONS FROM TESTS TAKEN ON MR. D.

The tendency of the results of the normal tests is to show a decrease in heart rate and blood pressure. The exceptions occur in test 3/30, in

which the heart rate in the vertical position increased 4 beats and in test 4/6, in which the blood pressure increased in both the horizontal and vertical positions. According to this the conditions were favorable to the subject.

If, however, the greater range of heart rate and blood pressure are considered, the conditions are unfavorable, since in test 3/30 there is a greater difference in heart rate and blood pressure at the end of the period and in test 4/3 the difference in blood pressure is greater.

This subject also objected to the cigar test because of nausea it caused, and after the test taken on 4/6 cigarettes were used.

The one cigar test taken shows the rise in heart rate and the rise in blood pressure in the horizontal position, followed by a fall of pressure in the vertical position, which is characteristic of the tests taken on the other novices.

As in the case of the other non-smoker, on whom cigarette tests were made, there were no changes of a serious character.

PART II

EFFECTS OF SMOKING ON THE RETURN OF THE HEART RATE TO NORMAL AFTER EXERCISE

Experimental Work by
GLENN A. DOWLING

International Young Men's Christian Association College
Springfield, Mass., 1916

II

EFFECTS OF SMOKING ON THE RETURN OF THE HEART RATE TO NORMAL AFTER EXERCISE

As a result of his experimental work, Mr. Payne concluded that the control of the heart was seriously impaired by smoking. This was shown by a higher heart rate in smokers, but Payne also noticed, though he had no figures to establish his observation, that the smokers' hearts seemed more irregular and more subject to distracting influences than those of the non-smokers. This suggested that the smoker's heart might be more affected by exercise than the non-smoker's heart, and that it might not return to normal after exercise as quickly as that of the non-smoker. Mr. Glenn A. Dowling addressed himself to a definite study of this problem.

Fifteen men were chosen for this work, seven of whom were non-smokers and eight classed as smokers, although smoking only three or four times per day. These latter we would then class as moderate smokers.

These men were all young and healthy, taking vigorous exercise each afternoon. Having supper

at six, they came to the smoking laboratory a short time after they had eaten. They were asked to rest for several minutes after arriving in the room, in order to produce normal conditions of the heart rate after the exercise of coming to the laboratory.

With the non-smokers the heart rate was taken for a full minute by palpitation on the radial artery at the wrist. Immediately, they took 20 jumps over a bar 18 inches from the floor at the rate of 80 jumps per minute, a metronome being used to beat time. This was to insure a similar dosage for each subject. After this exercise the heart rate was again taken, but only for 15 seconds. Following this the heart rate for the first 15 seconds of each succeeding minute was taken, or until the heart rate had returned to normal. The number of minutes, namely 15, for extending the taking of the heart rate was entirely arbitrary. It was impossible for students having several hours of studying to do in the same evening, to remain longer than an hour and twenty or thirty minutes, which was usually the time taken to smoke two cigars and complete the experiment. This procedure for the non-smokers continued through five or more experiments, in order to get a normal return of the heart rate after a controlled amount of exercise had been given. Then the same procedure was repeated

with non-smokers for at least five experiments, in most cases ten, except that they were required to smoke two cigars after their normal heart rate had been taken.

With the smokers we proceeded as in the latter half of the non-smokers' tests, i. e., normal heart rate for full minute, smoke two cigars, heart rate for first fifteen seconds of each succeeding minute, or until heart rate returned to normal. When these men had smoked for ten tests they discontinued all smoking for a period of two weeks or longer, after which the same procedure was followed as at first with the non-smokers, i. e., normal heart rate etc., without the smoking of two cigars.

With these conditions of the test, comparisons may be made between smokers and non-smokers, between the condition of smokers when they smoked and when normal, between conditions of non-smokers when they smoked and when normal.

For this work a good quality ten-cent cigar of medium color was used throughout.

An outline of the procedure is here given, in order to show more graphically what was done.

As before, the first letters of the alphabet, A, B, C, etc., represent the non-smokers and the later letters represent smokers.

OUTLINE OF PROCEDURE

NON-SMOKERS

Without Smoking. For five tests.

1. Arrival at laboratory.
2. A rest of several minutes.
3. Horizontal heart rate for full minute.
4. Twenty jumps over bar 18 inches from floor.
5. Heart rate for first 15 seconds of each minute following, up to the 15th, or until heart rate returns to normal.

Smoking. For five to ten tests.

1. Arrival at laboratory.
2. Rest for several minutes.
3. Normal heart rate taken.
4. Smoke two cigars.
5. Twenty jumps over bar 18 inches from floor.
6. Heart rate for first 15 seconds of each minute following, up to the 15th, or until heart rate had returned to normal.

SMOKERS

Smoking. For five to ten tests.

1. Arrival at laboratory.
2. Rest of several minutes.
3. Normal heart rate taken.
4. Smoke two cigars.
5. Twenty jumps over bar 18 inches from floor.
6. Heart rate for first 15 seconds of each min-

ute following, up to the 15th, or until heart rate returned to normal.

Without smoking. For five tests.

After discontinuing smoking for two weeks.

1. Arrival at laboratory.
2. Rest of several minutes.
3. Normal heart rate taken.
4. Twenty jumps over bar 18 inches from floor.
5. Heart rate for first 15 seconds of each minute following, up to the 15th, or until heart rate returned to normal.

The series of observations taken on Mr. B., a non-smoker, follow as an example of the data collected. The complete collection of individual tables will be found in the appendix to Part II.

Mr. B.

Date	Condition	Hr. of experiment	Normal H. R.	Time in min. taken to smoke	H. R. for 1st 15 sec. of 1st min.
1-14-15	Good	7.15	84		35
1-18-15	"	8.15	82		34
1-30-15	"	8.00	72		36
2- 2-15	"	8.00	81		32
2- 4-15	"	8.10	82		36
2- 8-15	"	7.25	96		36
Average			82.6		34.8
2-19-15	"	7.10	80	69	39
3- 8-15	"	7.20	78	68	32
4-15-15	"	7.00	74	50	33
4-21-15	"	7.00	80	54	32
4-23-15	"	1.15	98*	59	39
Average			82	60	35

* Had been exercising quite vigorously half hour before.

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H.R. for first 15 seconds of following minutes

															Min. H.R. re- turned normal.
2	3	4	5	6	7	8	9	10	11	12	13	14	15		
26	21	25	24	20	21									7	
22	20	20	21	20										3	
30	19	18	18	18										4	
22	21	20	20	20										4	
19	21	22	22	21	21									3	
27	26	25	24	24	24									5	

Average															5.2
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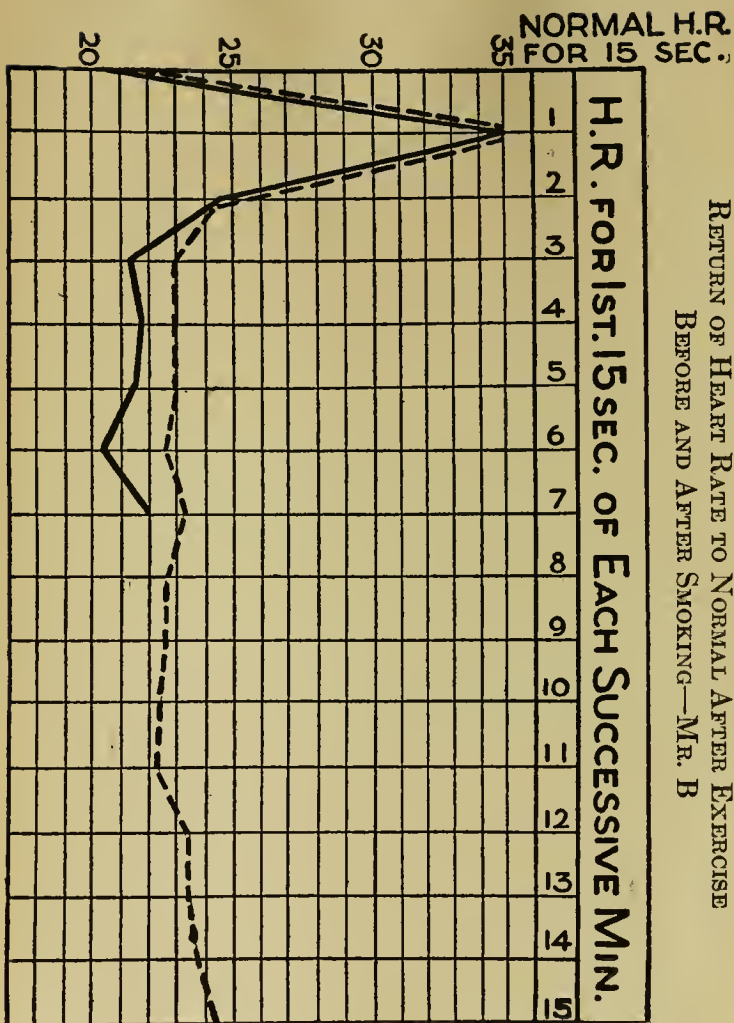
21	18	20	20	20	20										4
22	21	20	21	21	21	19	20	19	19						8
25	25	24	24	23	24	23	23	24	23	23	24	23			*
24	22	23	23	22	25	23	22	21	22	22	21	22	23		*
30	28	27	27	26	26	26	26	26	26	26	26	26	26	26	*

Average															11.4
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* Heart rate had not returned to normal in the 15th minute.

The above table may be made visible by averaging the rate for the first 15 seconds of each successive minute and plotting as in the following chart.

RETURN OF HEART RATE TO NORMAL AFTER EXERCISE
BEFORE AND AFTER SMOKING—MR. B



In this manner 193 experiments were conducted on 15 men as indicated in the following table:

NUMBER OF TESTS TAKEN			
NON-SMOKERS	Without Smoking	Smoking	
A	5	10	
B	6	5	
C	5	10	
D	6	10	
E	5	5	
F	5	5	
G	5	5	
		37	50
		Total 87	
SMOKERS			
X	5	10	
Y	5	10	
Z	6	10	
M	5	10	
N	5	10	
S	2	2	
T	5	6	
W	5	10	
		38	68
		Total 106	
		193	

The general tables of averages and comparisons will show the results.

TABLES OF AVERAGES AND COMPARISONS

TABLE I.—When men did not smoke

	Average of individual man's H. R.	H. R. average of individual man for 1st 15 sec. of 1st min. after exercise.
A	80.8	36
B	82.6	34.8
C	79.2	38
D	90.5	37.2
E	72	34
F	71.2	33.6
G	73.8	34.4
Average	78.6	35.1

	Average of individual man's H. R.	H. R. average of individual man for 1st 15 sec. of 1st min. after exercise.
X	88	35
Y	80	35.8
Z	78.8	36.6
M	71.4	35.4
N	73.8	34.6
S	88	40
T	85.8	32
W	85.8	34.8
<hr/>		
Average	81.5	35.5

Table I shows the average heart rate of all the men when normal, that is, not smoking.

The average normal heart rate for non-smokers is 78.6 beats per minute, while for the smoker it is 81.5 beats per minute, demonstrating that the heart rate of smokers is higher than that of non-smokers.

This conclusion verifies conclusion 4 of J. W. Payne's study of 1914, to the effect that cigar smoking increases heart rate.

The average heart rate for the first 15 seconds of the first minute after exercise when not smoking, for non-smokers is 35.1 beats, for smokers is 35.5 beats. There seems to be no decided difference between non-smokers and smokers when not smoking, as to the height of increase of heart rate for the first minute after exercise.

TABLE II.—When men smoked

NON-SMOKERS	Nor. average H. R. before smoking	Time in min. taken to smoke	H. R. for 1st 15 sec. of 1st min. after exercise
A	83.8	63.6	34.9
B	82	60	35
C	81.8	59.5	39.8
D	87.3	59.9	39.4
E	64.2	58.4	33.8
F	84.2	61.2	33.9
G	73.8	60.2	33.2
Average	79.6	60.4	35.7
SMOKERS			
X	79.7	62.2	36.6
Y	78.9	61.2	34.5
Z	72.2	59.1	38.3
M	76.5	59.2	35.2
N	80.2	60.4	39.2
S	88.5	60	44
T	89.2	60.2	37
W	86.6	60.7	35.3
Average	81.5	60.4	37.5

Table II shows the average heart rate of all the men when they smoked.

During this period of time, when the non-smokers smoked, we find an increase of heart rate of one beat per minute as compared with the period when they did not smoke. This also proves that smoking increases the heart rate. We also find the heart rate of non-smokers lower than that of the habitual smoker.

The average length of time for both groups to smoke two cigars was 60.4 minutes.

The heart rate for the first 15 seconds of the

first minute after exercise for smokers was 1.8 beats higher than for non-smokers. Multiplying this rate by four to get the rate for a whole minute in order to compare with normal heart rate, we find that the heart rate for the first minute after exercise in relation to the normal heart rate is correspondingly greater by 5.5 beats for smokers than for non-smokers. Therefore the statement can be made that the heart rate of smokers after exercise is higher than non-smokers.

TABLE III

Time required for heart rate to return to normal after exercise.

Non-Smokers	Without Smoking, i.e. Normal	Smoking	Out of the 86 experiments from which these figures are taken—49 tests with smoking—in 37 of the tests with smoking, the heart rate did not return to normal, but inasmuch as H. R. was taken only until the 15th minute, the number 15 was used in averaging.
A	6.8	6.9	
B	5.2	11.4	
C	4.4	15	
D	6.7	13.9	
E	4	15	
F	4	15	
G	3.8	13.2	
Average	5	12.9	
Smokers			Out of 103 experiments—65 smoking, in 39 H. R. did not return to normal in 15 minutes, so 15 was taken for averaging.
X]	5.2	15	
Y	5.6	7.4	
Z	5.4	14.4	
M	4.2	9.5	
N	5.4	11.2	
S	5	15	
T	6.16	13.5	
W	4.6	10	
Average	5.2	12	

Table III shows a comparison of the minutes at which the heart rate returned to normal when men did not smoke and when they did smoke.

Out of 118 experiments when the men smoked, the heart rate in 74 increased and failed to return to normal after exercise within 15 minutes. This is a percentage of 62.72.

Non-smokers smoked 50 times. Out of this number 36 increased in heart rate and did not return to normal in 15 minutes. This is a percentage of 72.

Smokers smoked 68 times. Out of this number 38 increased in heart rate and failed to return to normal in 15 minutes. This is a percentage of 55.80.

For non-smokers not smoking, the average return of the heart rate to normal after exercise was 5 minutes. With smoking the average return to normal was 12.9 minutes, averaging X as 15 minutes (X indicating that heart rate had not returned to normal within 15 minutes, which was as long as experiment was continued).

For smokers not smoking the average return of the heart rate to normal after exercise was 5.2 minutes, which is but slightly longer than for non-smokers. When smoking, the average return to normal was 12 minutes.

With non-smokers the difference, when smoking and not smoking, of the average minutes that

the heart rate returned to normal, was 7.9 minutes. With the smoker the difference was 6.8 minutes. This shows that smoking caused the heart to work longer to accomplish a given amount of work.

The fact that there was a difference of 6.8 minutes with smokers in the average return of the heart rate to normal after exercise when smoking and not smoking, shows that a man has become habituated to tobacco smoking psychologically, yet physiologically his system never becomes accustomed to it, to the extent that it is not affected.

TABLE IV

This table shows a comparison of the average normal H. R. and the average increased H. R. for the 15th minute in all those cases of smoking where the heart rate after exercise had not returned to normal at 15th minute.

	No. of times H. R. increased and did not return to normal in 15 minutes.	Number of times of smoking test.	Av. Nor. H. R. of number of times indicated in column 1.	Average of H. R. for 15 seconds of 15th min.	Av. of H. R. for 60 sec. of 15th min.	No. of beats difference between what H. R. was for whole of 15th min. and nor.
A	3	10	75	21	84	9
B	3	5	84	23.3	93.4	9.4
C	10	10	81.8	23.9	95.6	13.8
D	7	10	85	23.3	93.4	8.4
E	5	5	64.2	20.2	80.8	16.6
F	5	5	84.2	23	92	7.8
G	4	5	72.7	21.7	86.8	14.1
Total	36	50				
Average			78.1	22.4	89.4	11.3

	No. of times H. R. increased and did not return to normal in 15 minutes.	Number of times of smoking test.	Av. Nor. H. R. of number of times indicated in column 1.	Average of H. R. for 15 seconds of 15th min.	Av. of H. R. for 60 sec. of 15th min.	No. of beats difference between what H. R. was for whole of 15th min. and nor.
X	9	10	79.2	22.8	91.2	12
Y	2	10	76	20.5	82.0	6
Z	9	10	72.2	20.1	80.4	8.4
M	3	10	71.3	19.7	78.8	7.5
N	4	10	76	22	88	12
S	2	2	88.5	24.5	98.0	9.5
T	5	6	87.4	28.2	112.8	25.4
W	4	10	80.7	22.5	90	9.3
Total	38	68				
Average			78.9	22.5	90	11.1
Total	74	118				

Table IV shows after exercise that the average heart rate for the 15th minute in 72 per cent of the tests when non-smokers smoked was 11.3 beats per minute higher than normal.

In 55.8 per cent of the cases when smokers smoked the average heart rate in the 15th minute was 11.1 beats per minute higher than normal.

In this comparison of normal heart rate and increased heart rate after exercise there seems to be but little difference between smokers and non-smokers. Out of 118 tests when both smokers and non-smokers smoked, the heart rate increased in 74 tests or 62.72 per cent and at the 15th minute had not returned to normal.

This average increase at the 15th minute was 11.2 beats per minute higher than at normal.

The total general effect of smoking in delaying the return of the heart rate to normal after exercise may be shown by averaging the heart rate for each 15 seconds for each man and then getting the grand average for each group. This is done in Table V and the general result is visualized by plotting for the groups as was done in the case of Mr. B.

The table and chart for smokers would be almost identically the same as the above and is therefore omitted. It should be noted that this curve hardly portrays the true significance of the delayed return since the averages *before smoking* are often taken from individual cases. These individual cases are frequently nearly as high as after smoking. The true picture of the situation lies in the *few* cases that failed to return to normal after seven minutes before smoking and the *large* number that failed to return to normal after fifteen minutes after smoking.

CONCLUSIONS

I. Smokers have a normal heart rate higher than non-smokers.

II. Smoking causes a delay in the return of the heart rate to normal after exercise. As evi-

TABLE V.—GRAND AVERAGES

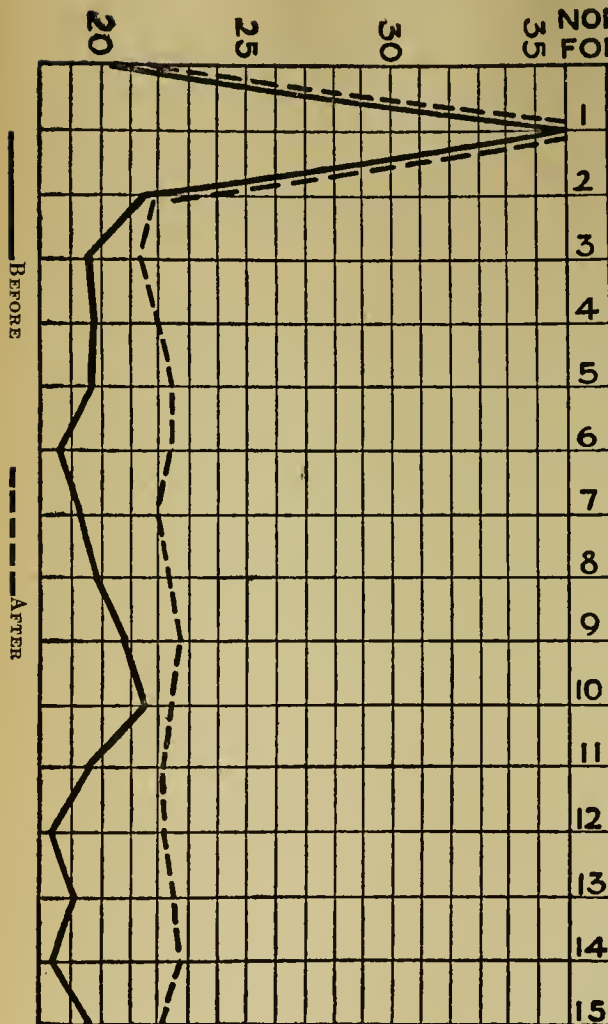
NON-SMOKERS

	15 Sec. Normal	1st	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Before: A	20.2	36.0	20.6	21.4	21.4	22.0	21.2	20.7	21.3	20.0	19.0	19.5	18.5	19.0	18.5	19.5
B	20.7	34.8	24.3	21.3	21.7	21.5	20.5	22.0								
C	19.8	38.0	25.4	20.8	20.0	20.2	20.2	20.5	19.0	19.0						
D	22.6	37.2	21.5	20.8	22.3	23.0	23.0	23.3	23.3	23.5	24.0					
E	18.0	34.0	18.0	18.6	18.0	17.3	14.0	14.0								
F	17.8	33.6	18.8	17.8	17.8	17.8	16.0	17.0	17.0							
G	18.5	34.4	19.4	17.8	18.0	17.0	17.0	18.0	18.0							
Average	19.7	35.4	21.1	19.8	19.9	19.8	18.8	19.3	19.7	20.8	2.15	19.5	18.5	19.0	18.5	19.5
After: A	20.9	34.9	21.6	21.5	21.7	21.9	22.0	20.8	20.5	21.5	21.0	20.5	20.5	21.5	21.0	21.0
B	20.5	35.0	24.4	23.0	23.0	23.0	22.4	23.2	22.8	22.8	22.5	22.5	23.7	23.7	23.7	24.2
C	20.5	39.8	24.3	23.8	23.7	24.5	24.4	24.3	24.1	24.2	24.9	24.2	24.2	23.9	24.0	24.1
D	21.8	39.4	21.8	22.5	23.5	23.4	23.9	22.9	23.2	23.5	23.8	23.1	23.1	22.9	23.3	23.6
E	16.1	33.8	16.2	17.6	19.0	19.4	19.8	20.0	20.4	21.0	20.4	20.4	20.4	20.2	20.4	20.4
F	21.1	33.9	22.8	21.8	23.2	22.6	22.6	23.2	23.2	23.2	23.0	23.0	23.0	23.0	23.0	23.0
G	18.5	33.2	21.4	22.0	21.8	22.6	22.2	21.8	22.4	22.0	22.2	21.8	22.0	21.7	21.7	21.7
Average	19.9	35.7	21.8	21.7	22.3	22.5	22.2	22.5	22.4	22.6	22.5	22.2	22.4	22.4	22.8	22.6

RETURN OF HEART RATE TO NORMAL AFTER EXERCISE NON SMOKERS GROUP AVERAGES

NORMAL H.R.
FOR 15 SEC.

H.R. FOR 1ST 15 SEC. OF EACH SUCCESSIVE MIN



denced in this study, this delay is 7.9 minutes for non-smokers and 6.8 minutes for smokers.

III. Equilibrium of heart rate is not established in habitual smokers, i. e., the body does not become accustomed to smoking, for there is but a slight difference in the length of time of the return of the heart rate to normal between smokers and non-smokers.

IV. To the writer the most important conclusion as shown by the work is that:—

(a) In 74 tests out of 118 smoking tests, or 62.72 per cent, the heart rate was increased and did not return to normal at the 15th minute. In 72 out of 74 tests without smoking, 97 per cent of all the tests taken, the heart rate returned to normal in less than fifteen minutes, the average time being only five minutes.

(b) The average heart rate at the 15th minute was 11.2 beats greater than the average normal heart rate.

These experiments are exceedingly convincing. They are also exceedingly original. They show that the smoker apparently does not become habituated to the use of tobacco, that exercise disturbs him more than the non-smoker, that physical work causes more of a disturbance in organic function in those who smoke than in

those who do not. Apparently, therefore, athletic coaches have been wise in asking their athletes to give up smoking when training. We would imagine also that the non-smoker, other things being equal, would make the better workman, for he can work with less disturbance to organic function.

The individual detailed tables are given in the appendix, so that those desiring to do so can follow absolutely every detail of the experiment. Attention is called to the general uniformity and consistent results shown by the tables.

APPENDIX TO PART II

TABLES OF INDIVIDUAL DATA WITH EXPLANATIONS

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	Mr. A. H.R. for
					1st 15 sec. of 1st min.
1-21-15	Good	6.30	90		42
1-22-15	"	6.30	68		30
1-28-15	"	7.15	74		40
1-26-15	"	7.00	88		33
1-30-15	"	6.50	84		35
Average			80.8		36
2- 4-15	"	6.30	70	58	32
2-10-15	"	6.30	68	61	28
2-16-15	"	6.30	98	63	35
2-17-15	"	6.50	92	71	36
2-19-15	"	6.30	90	70	32
2-24-15	"	6.40	80	68	37
2-25-15	"	6.40	84	52	40
3- 2-15	"	6.40	89	63	39
3- 3-15	"	6.40	83	68	35
3- 4-15	"	6.40	84	62	35
Average			83.8	63.6	34.9

H.R. for first 15 seconds of following minutes:

														Min. H.R.
2	3	4	5	6	7	8	9	10	11	12	13	14	15	returns to normal
20	23	23	23	22	23	22								6
19	21	20	19	20	19	20	19	19	20	18	19	19	20	*
21	22	21	24	21	20	22	21	19	19	19	19	18	19	10
23	19	22	22	22										4
20	22	21	21	21										4
Average														6.8
20	19	20	21	20	21	20	20	19	18	18	20	19	19	†
17	17	19	19	18	17	17								7
27	25	24	24											4
22	23	23	23	23										4
21	22	22	22	22										3
20	21	20	20											3
24	23	25	25	25	24	24	23	23	23	23	23	23	23	††
20	21	22	22	23	22									6
21	23	21	22	23	20	21								8
24	21	21	21											4
Average														6.9

* H.R. had not returned to normal in the 15th minute.

† Became nauseated.

†† Felt rather sick, a little bit dizzy.

HEART RATE AFTER EXERCISE

65

Mr. B.
See tables on page 49

Mr. C.

Date	Condi- tion	Hr. of Ex- periment	H.R. Normal	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st min.
1-14-15	Good	6.30	82		37
1-19-15	"	7.10	84		40
1-21-15	"	7.00	80		36
1-23-15	"	6.30	72		36
1-27-15	"	7.15	78		41
Average			79.2		38
1-28-15	"	6.30	76	58	45
2- 2-15	"	6.30	78	61	38
2- 4-15	"	6.30	80	63	36
2- 8-15	Hard Cold	6.35	88	59	41
2-11-15	Good	6.30	72	60	42
2-16-15	"	6.30	90	58	41
2-17-15	"	6.30	74	56	38
2-24-15	"	6.40	84	60	38
2-25-15	"	7.00	84	58	38
3- 2-15	"	7.00	92	62	41
Average			81.8	59.5	39.8

H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
28	22	21	21	21	21									4
26	21	21	21	21										3
24	21	20	20											4
23	21	20	21	21	20	19	19							8
26	19	18	18	18										3
Average														4.4
25	25	25	25	25	25	24	24	23	22	22	22	22		*
23	22	22	23	23	23	23	23	22	22	24	21	24	23	*
26	24	22	22	22	23	23	22	23	22	23	23	24	23	*
25	26	25	26	25	25	24	24	24	26	25	25	24		*
21	22	23	22	23	21	23	24	23	22	23	23	24	23	*
26	27	26	27	26	26	26	26	25	26	25	25	25	25	*
22	21	23	25	24	24	24	24	23	25	24	24	23	24	*
25	25	24	25	25	26	25	26	26	26	25	26	25	25	*
24	23	24	25	26	25	24	25	25	26	25	25	24	25	*
26	23	23	25	25	25	25	24	25	25	26	25	25	25	*

Average

* or 15 min.

* H. R. had not returned to normal at the 15th minute.

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Date	Condi- tion	Mr. D. Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st min.
1-14-15	Good	6.30	88		32
1-19-15	"	7.15	89		38
1-22-15	"	7.00	96		42
1-27-15	"	7.30	94		34
1-28-15	"	7.00	96		42
1-26-15	"	7.15	80		35

Average			90.5		37.2
1-30-15	"	6.30	80	61	34
2- 2-15	"	7.00	81	60	42
2- 4-15	"	6.30	84	63	40
2- 8-15	"	6.45	80	58	42
2-10-15	"	6.30	104*	56	40
2-11-15	"	6.35	94	51	41
2-16-15	"	6.40	90	62	39
2-17-15	"	6.30	88	70	37
2-25-15	"	6.35	82	61	40
3- 2-15	"	6.40	90	57	39

Average		87.3	59.9	39.4
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* Normal H. R. was taken several times and at intervals of three to five minutes for three or four times without a decrease in H.R.

H.R. for first 15 seconds of following minutes:															Min. H.R. returned to normal
2	3	4	5	6	7	8	9	10	11	12	13	14	15		
19	20	22	22	22	22										4
20	24	21	22	21	22										5
23	23	27	26	25	24	24									7
22	19	22	23	23	24	23	23								8
27	22	23	25	26	28	23	24	24							10
18	17	19	19	20	20										6

Average															6.7
23	20	21	22	19	18	21	21	21	20	20					11
22	22	23	23	23	23	22	23	23	22	23	21	21	22		*
23	22	23	23	22	23	23	24	25	24	24	23	24	24		*
21	20	25	23	22	22	22	22	24	21	21	21	22	22		*
22	23	24	24	23	24	24	24	24	23	24	24	23	24		† Decrs.
20	23	22	23	22	22	24	23	23	23						9
23	26	26	24	24	25	24	24	25	25	24	24	24	24		*
21	24	24	25	25	25	24	25	24	25	24	25	24	25		*
22	24	23	23	24	23	23	25	24	23	23	23	23	23		*
21	21	24	24	25	24	25	24	25	25	25	25	25	25		*

Average															13.9
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* H.R. had not returned to normal in the 15th minute.

† Not used in averaging for increase of H.R.

Mr. E.					
Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st min.
1-19-15	Good	6.30	56		33
1-27-15	"	6.30	70		31
1-28-15	"	7.00	76		35
1-26-15	"	7.10	72		35
2- 9-15	"	7.00	86		36
Average			72		34
2-11-15	"	6.30	70	50	34
2-17-15	"	7.30	64	59	34
3- 3-15	"	7.00	60	63	31
4- 2-15	"	7.00	61	58	31
4- 6-15	"	1.35	66	62	39
Average			64.2	58.4	33.8

H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
15	14	15	16	14	14									6
16	18	17	18											4
19	19	19												3
24	21	18	18											4
16	21	21												3
Average														4

19	18	18	20	21	21	21	21	22	19	20	20	20	20	*
15	17	19	19	19	19	20	21	19	21	20	20	20	20	*
17	19	20	20	21	20	22	22	22	21	22	21	22	22	*
15	16	18	18	18	20	20	20	20	20	20	20	20	20	*
16	18	20	20	20	20	19	21	19	21	20	20	20	20	*

Average

* or 15

* H.R. had not returned to normal in the 15th minute.

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Mr. F.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st min.
1-21-15	Good	7.30	69		39
1-22-15	"	7.00	72		36
1-26-15	"	7.00	72		30
2- 9-15	"	6.30	65		31
2-10-15	"	6.35	78		32

Average			71.2		33.6
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SMOKING

2-17-15	"	7.30	86	68	33
3- 3-15	"	7.15	80	62	35
3- 4-15	"	7.00	77	54	32
4- 2-15	"	6.40	92	52	36
4- 6-15	"	6.30	86	70	33

Average			84.2	61.2	33.9
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H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
19	18	17	17	16	17	17								4
19	18	18	18											3
18	18	18												3
18	14	16	16											4
20	21	20	20											6

Average														4
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17	22	24	22	22	24	24	23	23	24	23	24	23	24	*
27	20	23	23	24	23	22	25	23	22	22	23	22	23	*
25	20	19	21	20	21	20	21	20	22	21	20	21	21	*
27	24	26	25	25	25	25	24	25	24	24	24	25	24	*
18	23	24	22	22	23	24	23	24	23	24	23	24	23	*

Average														* or 15
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* H.R. had not returned to normal in the 15th minute.

Mr. G.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st min.
1-22-15	Good	7.00	77		36
1-28-15	"	6.45	64		30
1-26-15	"	6.30	72		32
2- 2-15	"	6.30	84		38
2- 2-15	"	6.45	72		36

Average			73.8		34.4
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2- 8-15	"	6.30	78	60	36
2-11-15	"	6.30	78	67	32
2-17-15	Slight cold	6.30	69	56	32
3- 3-15	Good	6.30	67	59	33
3-30-15	"	6.30	83	65	33

Average			73.8	60.2	33.2
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H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
19	19	19												3
17	16	16												3
17	15	16	16	17	18	18								7
22	21	21												3
22	18	18	18											3

Average														3.8
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23	25	23	24	24	23	23									6
19	21	21	21	21	21	21	21	21	21	21	21	21	21		*
20	20	22	23	21	21	23	22	22	22	21	21	21	21		*
21	20	21	21	21	20	21	21	21	20	22	21	21	21		*
24	24	22	24	24	24	24	24	25	24	24	24	24	24		*

Average															13.2
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* H.R. had not returned to normal in the 15th minute.

70 PHYSICAL EFFECTS OF SMOKING

Mr. X.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st min.
1-18-15	Good	6.50	70	65	40
1-19-15	"	6.30	59	62	40
1-21-15	"	6.30	88	68	39
1-22-15	"	6.40	92	65	36
1-26-15	"	6.30	84	61	33
1-28-15	"	6.30	96	62	36
1-30-15	"	6.30	79	58	36
2- 2-15	"	6.30	73	56	35
2- 4-15	"	6.30	78	62	35
2-10-15	"	6.40	78	63	36

Average			79.7	62.2	36.6
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3- 2-15	"	7.00	80		35
3- 3-15	"	*6.35	92		34
3- 8-15	"	6.30	86		39
3- 9-15	"	6.30	90		40
3-10-15	"	7.00	96		34

Average			88		36.4
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* Had worked hard.

H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
21	22	20	22	19	21	22	21	19	23	20	21	19	19	
19	19	23	21	21	22	20	22	22	22	22	22	22	22	
23	26	25	24	25	24	25	24	25	25	25	25	25	25	
24	26	28	26	29	26	26	26	25	25	26	26	26	25	
28	24	23	20	19	20	20	20	20	20	20	22	21	21	*Decrs
32	28	28	24	24	25	24	26	26	26	26	26	25	25	
32	28	28	24	24	24	24	24	26	26	26	26	26	24	
20	24	24	22	22	22	22	20	24	23	21	25	23	22	
19	22	22	22	22	22	22	22	22	22	24	21	22	21	
23	25	24	22	22	25	23	24	23	24	23	23	23	23	

Average														15
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19	20	21	21	21	21	20	21	21	20	20				5
25	21	22	23	23										5
21	23	23	21	21										5
23	19	23	22											5
23	22	24	24											4

Average														5.2
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* Not used in averaging for increase of H.R.

Mr. Y.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st min.
1-18-15	Good	7.50	68	63	34
1-19-15	"	*7.15	64	66	31
1-20-15	"	7.00	79	62	35
1-21-15	"	7.00	79	68	39
1-26-15	"	7.05	78	59	34
1-28-15	"	7.10	80	62	31
2- 2-15	"	†7.00	95	55	35
2- 4-15	"	7.10	88	59	40
2-10-15	"	7.20	78	56	35
2-12-15	"	7.00	80	62	31
Average			78.9	61.2	34.5

4-20-15	"	1.00	81		32
4-23-15	"	1.15	73		32
4-26-15	"	6.30	82		39
4-27-15	Stomach-ache	6.30	79		37
4-28-15	Good	6.30	85		39
Average			80		35.8

* Up until 1.00 a. m.

† Swimming hard.

H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
22	19	17	17	17										4
22	21	18	17	17	17	18	17	17	18	17	19	17	17	*
23	19	19	19	19	19									3
20	21	23	21	21	20	20								7
26	23	23	21	20	18	19	18	19						8
22	19	20	19	19	19	19	20	19	20	20				9
23	24	24	23	24	23									4
23	24	25	23	24	23	23	24	24	23	24	24	23	24	*
19	20	19	19											4
23	17	17	19	20	19	20								6
Average														7.4

18	19	19	21	20	21									5
19	18	21	18	18										5
20	23	21	21											4
24	22	22	22	22	22	22	22	23	23	23	22	22	23	*
23	21	21	21	22	22	21	22	22	21	22	21			4

Average

5.6

* H.R. had not returned to normal in the 15th minute.

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Mr. Z.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st 15 min.
1-19-15	Good	6.30	57	62	33
1-21-15	"	6.50	72	65	36
1-22-15	"	8.00	70	58	45
1-26-15	"	6.30	62	62	36
1-28-15	"	6.30	73	56	42
1-29-15	"	6.30	72	61	35
2- 2-15	"	6.35	71	53	39
2- 4-17	"	7.00	81	58	41
2-11-15	"	7.00	88	62	40
2-16-15	"	6.25	75	61	36
Average			72.2	59.1	38.3
3- 8-15	"	6.30	78		36
3- 9-15	"	6.30	85		42
3-10-15	"	6.30	74		35
4-20-15	"	1.15	76		34
4-21-15	"	1.00	80		36
4-22-15	"	1.15	80		35
Average			78.8		36.6

H.R. for 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
22	18	20	20	20	20	19	19	19	20	20	20	20	19	*
17	17	17	17	18	19	19	18	18	18					6
23	21	21	19	21	21	20	21	20	19	21	20	20	20	*
16	18	20	19	19	19	19	19	19	20	19	20	19	19	*
21	20	21	20	20	20	23	20	20	20	20	20	20	20	*
18	21	21	19	19	19	20	20	19	19	20	19	17	17	*
22	20	20	21	21	22	20	20	20	21	22	22	22	19	*
22	19	23	24	23	23	23	23	23	23	21	22	21	21	*
21	22	20	22	20	22	20	23	21	23	21	21	21	21	*
23	20	22	21	21	21	22	22	23	22	23	23	24	23	*
Average														14.4
22	20	20	20	19	20									6
20	21	21	21											3
21	18	20	20	19	19									6
20	20	19	19											4
21	19	22	20	20										5
21	19	20	20											3
Average														5.4

* H.R. had not returned to normal in the 15th minute.

Mr. M.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st 15 min.
1-18-15	Good	7.15	78	61	29
1-19-15	"	7.00	79	67	33
1-21-15	"	7.10	92	58	40
1-22-15	"	7.00	78	55	36
1-27-15	"	7.00	80	60	34
1-28-15	"	7.00	80	65	34
1-29-15	"	7.00	66	62	35
1-30-15	"	6.50	74	53	36
2- 4-15	"	7.00	74	60	40
2- 8-15	"	7.00	74	51	35

Average			76.5	59.2	35.2
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3- 2-15	"	7.00	71		31
3- 3-15	"	7.00	78		39
4-20-15	"	6.30	68		38
4-18-15	"	1.00	72		35
4-21-15	"	6.35	68		34

Average			71.4		35.4
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H.R. for first 15 seconds of following minutes:

																Min. H.R. returned to normal
2	3	4	5	6	7	8	9	10	11	12	13	14	15			
26	22	20	19	20	18	19										5
28	27	24	22	21	19	19	19	19								7
30	26	27	25	23	23	23										6
25	21	21	21	20	20	19	20	19	19							8
23	20	21	20	19	18	21	20	20	20							9
22	21	22	22	20	20											6
23	22	20	22	20	20	20	20	20	19	19	19	19	19			*
25	18	21	23	21	19	19	18	19	18	19	18	19				9
26	20	24	20	20	20	20	20	20	20	20	20	20	20			*
22	22	22	22	22	22	21	21	20	20	20	20	20	20			*

Average																9.5
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18	18	19	18	18												5
23	20	19	20													4
20	17	18	17	17												5
19	21	18	18	18												4
21	17	17	17													3

Average																4.2
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* H.R. had not returned to normal in the fifteenth minute.

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Mr. N.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st 15 min.
1—18—15	Good	7.30	78	61	40
1—19—15	"	7.30	80	66	35
1—28—15	"	7.00	80	50	46
1—26—15	"	7.10	88	60	31
1—22—15	"	6.50	79	61	38
1—30—15	"	6.45	79	57	35
2— 4—15	"	7.10	74	62	46
2—19—15	"	7.00	71	65	45
2—21—15	"	7.30	84	63	42
2—25—15	"	6.45	89	59	34
Average			80.2	60.4	39.2
4—19—15	"	1.15	48 (?)		31
4—26—15	"	1.30	90		37
4—28—15	"	1.30	73		34
4—29—15	"	1.30	76		35
5— 2—15	"	1.30	82		36
Average			73.8		34.6

H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
25	28	21	21	22	21	20	18	19						10
23	21	19	21	18	19	21	20							9
24	23	23	23	25	22	23	23	23	23	24	23	23	23	*
18	19	20	20	20	20	20	20	20	20	20	20	20	20	† Decrs
23	20	20	21	19	19	19	18	19						9
22	28	27	23	24	24	23	24	23	22	24	25	26	25	*
16	17	22	21	23	21	21	21	21	21	24	25	24	22	*
16	17	22	21	22	21	23	21	21	23	21	22	21	22	*
17	18	17	22	20	20	21	21							8
20	22	21	20	22	21	22	21	22						6
Average														11.2
13	12	12	12											4
21	24	24	23	23										5
19	18	18	18	18										3
23	17	20	21	19	19									6
19	20	21	20	21	21									4
Average														5.4

* H.R. had not returned to normal in the 15th minute.

† Not used in averaging for increase of H.R.

Mr S.

Date	Condi- tion	Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	H.R. for 1st 15 sec. of 1st 15 min.
2-2-15	Good	7.00	93	58	45
2-4-15	"	7.00	84	62	43
Average			88.5	60	44
3-4-15	"	6.40	84		45
3-8-15	"	6.40	92		35
Average			88		40

H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
20	25	25	25	24	24	24	24	25	26	24	23	24	24	*
21	23	23	26	26	25	25	25	26	24	23	24	26	25	*
Average														* or 15
25	22	24	22	21	21									6
35	23	22	23											4
Average														5

* H.R. had not returned to normal in the 15th minute.

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Mr. T.

Date	Condi- tion	Hr.'of Ex- periment	Normal H.R.	Time in mins. taken to smoke	R.H. for 1st 15 sec. of 1st 15 min.
1-18-15	Good	7.30	78	65	31
1-27-15	"	7.00	89	50	36
2- 8-15	"	6.45	88	63	31
2-10-15	"	6.30	92	65	40
2-16-15	"	6.30	96	60	34
2-19-15	"	6.40	92	67	42

Average			89.2	60.2	37
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3- 3-15	"	6.45	82		28
3- 8-15	"	7.30	100		42
3-10-15	"	7.00	92		32
3-20-15	"	1.00	75		28
3-21-15	"	6.30	80		30

Average			85.8		32
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H.R. for first 15 seconds of following minutes:

2	3	4	5	6	7	8	9	10	11	12	13	14	15	Min. H.R. returned to normal
26	25	25	21	20	20	19	20							6
22	28	31	28	30	30	30	27	26	25	32	30	28	29	*
28	25	24	24	23	26	26	26	24	24	24	24	26	24	*
34	33	32	31	32	31	31	31	31	31	31	31	31	31	*†
34	28	27	29	32	31	30	31	31	30	30	30	29	29	*
29	27	28	28	28	27	30	28	29	28	27	28	27	26	*

Average														13.5
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23	21	22	22	20	21	20	21							6
30	27	26	28	25	25									6
25	25	25	25	23	23									7
23	19	17	18	19	19									6
22	21	21	21	20	20									6

Average														6.2
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* H.R. had not returned to normal in the 15th minute.

† This was continued for 27 minutes and the rate for any 15 sec. did not drop lower than 28 beats.

Date	Condi- tion	Mr. W.			H.R. for
		Hr. of Ex- periment	Normal H.R.	Time in mins. taken to smoke	1st 15 sec. of 1st 15 min.
1-22-15	Good	7.00	82	65	32
1-28-15	"	7.00	70	60	35
2- 8-15	"	7.00	98	57	40
2- 4-15	"	6.40	80	61	36
2-10-15	"	6.30	86	56	33
2-11-15	"	7.10	95	62	42
2-17-15	"	7.00	84	58	38
2-19-15	"	7.00	100	63	28
2-24-15	"	6.30	82	68	34
2-25-15	"	6.40	89	57	35
Average			86.6	60.7	35.3
3-30-15	"	6.45	91		36
3-31-15	"	7.00	83		34
4- 1-15	"	7.00	92		32
4- 2-15	"	6.45	83		34
4- 4-15	"	7.00	80		36
Average			85.8		34.8

H.R. for first 15 seconds of following minutes:

															Min. H.R. returned to normal
2	3	4	5	6	7	8	9	10	11	12	13	14	15		*†Decrs
18	17	19	20	20	20	20	20	20	20	20	20	20	20		*
18	17	19	20	20	20	20	20	20	20	20	20	20	20		4
26	24	26	24	24	24										*
26	22	22	21	21	21	21	21	21	21	21	22	21	21		5
22	19	21	21	22	21										4
24	24	24	26	24											*
27	23	22	23	25	26	26	25	25	25	25	25	25	25		4
23	23	25	24	23	25	25									8
18	20	21	22	23	21	21	21								*
24	24	23	23	24	24	23	25	24	24	24	24	24	24		
Average															10
24	23	22	22	22	23	22	23	22							4
21	20	20	21	20											5
21	22	23	23												4
17	18	19	21	21	21	21									5
18	19	22	20	20											5
Average															4.6

* H.R. had not returned to normal in fifteen minutes.

† Not used in averaging for increase of H.R.

PART III

THE EFFECTS OF SMOKING ON NEURO-MUSCULAR PRECISION

**Experimental Work by
G. WESLEY BLICKLEY**

**International Young Men's Christian Association College,
Springfield, Mass., 1915**

III

THE EFFECTS OF SMOKING ON NEURO-MUSCULAR PRECISION

The experiments extended over a period of four months with conditions as nearly uniform as possible.

The problem of precision tests and methods of determining physical accuracy and neuro-muscular control is a very broad one. Discussions of this and allied subjects may be found in Whipple's "Manual of Mental and Physical Tests" and in other publications. The most practical test which presented itself for use in this study for the finer coordinations was that furnished by the Columbia University Psychological Blanks No. 10. For the larger muscle groups it was decided to use lunging at a target with a fencing foil.

These tests were taken before and after smoking two cigars, and a system of scoring was adopted which would indicate the results of each man's performance. In this way exact figures show the score made by each man, with the per cent of loss or gain in physical precision regis-

tered for each individual experiment and averaged for the whole test.

The subjects for the work of this study were all young men leading healthy, active lives, taken from all classes in the college and varying in age from 19 to 24. For the sake of comparison seven smokers and seven non-smokers were selected. The smokers were men who perhaps never smoked more than twice in a day at the most, and would be classified as moderate smokers; and who, furthermore, discontinued even this amount of smoking during various seasons on account of training. On the other hand, many of the non-smokers had never used tobacco and took up the experiment merely from a personal interest in the subject. Owing to the unpleasant results, some found it impossible to finish the complete set of ten experiments. Practice teaching also interfered with some.

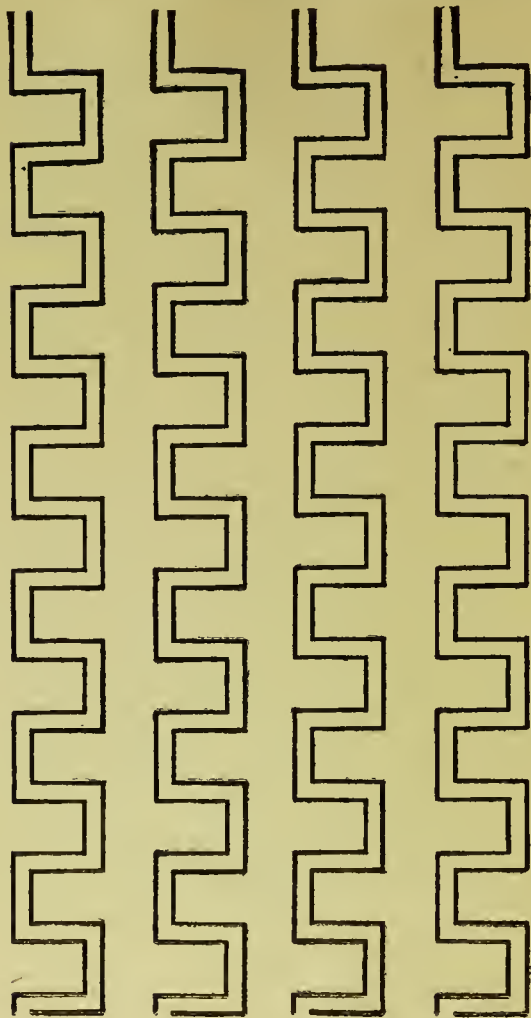
The room in which the tests were held was the smoking laboratory mentioned in the previous studies. It was well heated, well ventilated, and well lighted. There was plenty of ventilation, although it was our aim not to allow too much ventilation, as it was desired to have as nearly as possible the conditions of the club room, or the smoking car with the heavy cloud of smoke.

The men came for their experiments on evenings best suited to them, so that at any time when

they were not feeling well they were not required to come. In this way the experiments were obtained when the men were in the best of spirits, and at least when they were most likely to be normal. The subjects, whether smoking or not, were allowed to study, read, or write letters as they wished. It was noted, however, that the time was usually spent in conversation.

The cigars used were the same as in the previous tests. The men were required to smoke two cigars for each experiment, which took on the average from fifty to sixty minutes and more, the men setting their own pace.

The tests were two in number and were conducted as follows: Smokers—after a period of rest and after conditions had returned to their normal, and the normal heart rate had been taken by Mr. Dowling, each man was required to fill in two of the five lines on the Psychological Blank, which consisted in drawing a zigzag line between two other printed lines $3/16$ of an inch apart. The object of the test is to keep the third line from touching either of the other two lines. A fountain pen was used to draw these lines, and a metronome was used to time the men, 17 seconds for each line. A copy of the blank follows:



COLUMBIA UNIVERSITY PSYCHOLOGICAL BLANK No. 10

(By permission of Columbia University.)

Every time this zigzag line touched either line the subject was marked an error. An average of the errors registered in the first two lines were recorded as the score of this test before smoking.

Then followed the target test. This consisted of five thrusts with the foil in true fencing style—arm straight and with the lunge—at a target about fifteen inches in diameter, which is placed on the wall about shoulder high. A bull's-eye was registered as 6; for each succeeding concentric circle five, four, three, two, and one. The averages of these five scores were then taken and recorded as the score for that individual before smoking.

The subject was then allowed to smoke his two cigars, after which he filled in the remaining three parallel lines on the blank. The average, under the same conditions of scoring as before, was taken, and this recorded as the individual's score after smoking. The target test was then repeated and the average of the five thrusts recorded as the score after smoking.

Ten such experiments were taken and the scores totaled and averaged, after which each man was requested to refrain from smoking tobacco in any of its forms for a period of two weeks. A series of five experiments were then taken, similar to the ten above, with this exception that the scores were taken after exercise; the particular form of exercise used was twenty

jumps over a stick about eighteen inches high. This experiment was taken simply to satisfy a desire on my part to know the effect of exercise on neuro-muscular control. The scores were then totaled and averaged and the conclusions drawn.

Non-smokers—The tests on the non-smokers were much the same as those conducted with the smokers, except that the five experiments to obtain the normal and the effects on neuro-muscular control after exercise were taken first. The smoking tests were then taken after the normal had been recorded.

As there were but one or two trial experiments before the actual tests were started and as the men were not fully accustomed to the tests, we find that in most cases the non-smokers show an increase in physical precision in the normals taken immediately before smoking, and in the normals found for the first five experiments. But this is generally more than balanced by the percentage lost after smoking.

There are of course many outside influences which could have an effect upon the scores and which really should be considered. Chief of these is the fact of general improvement which the men show as a result of greater experience with the apparatus. There is also a difference in the scores registered by the different men as a result of their varied previous experience with the foil,

but this would not in any way affect the final percentages. With the smokers there is also a chance for decrease in efficiency during the two weeks' interval without smoking, due to lack of practice.

These are some of the considerations which must be taken into account in studying the results in the following tables. With these in mind, we can readily see why it is that the best one can hope for from the results obtained, is that they may be suggestive and a stimulus to further study.

Samples of the individual detailed tables follow and the complete set of detailed tables will be found in the appendix.

MR. P. SMOKER—BLANK TEST

BEFORE SMOKING

AFTER SMOKING

Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	4,8	12	6.0	12,15,12	39	13
1/19	14,4	18	9.0	13,11,14	38	12.66
1/21	3,9	12	6.0	10, 8,12	30	10.00
1/22	6,6	12	6.0	6, 4, 9	19	6.33
1/26	5,6	11	5.5	7, 3, 8	18	6.00
1/28	5,1	6	3.0	1, 2, 3	6	2.00
1/30	4,3	7	3.5	4, 5, 7	17	5.66
2/2	2,6	8	4.0	5, 5, 6	16	5.33
2/10	3,2	5	2.5	1, 2, 3	6	2.00
2/11	2,4	6	3.0	4, 5, 3	12	4.00
Totals		97	48.5		201	66.98
Averages		9.7	4.85		20.1	6.70

In this series of experiments Mr. P. lost in physical precision in eight out of the ten trials. In the trials of Jan. 28th and Feb. 10th a slight

increase was registered. The final average of 4.85 before smoking and 6.7 after smoking shows a decrease of 1.85 in the respective scores. This gives Mr. P. a loss of 38.13 per cent in physical precision.

MR. P. SMOKER—BLANK TEST WITH EXERCISE

Date	NORMAL		AFTER EXERCISE	
	Ind. Score	Total	Av.	
3/2	7,3	12	6	
3/3	5,4	9	4.5	
3/8	4,4	8	4.0	
3/9	3,4	7	3.5	
3/10	4,4	8	4.0	
Totals		44	22.0	
Averages		8.8	4.4	

By a comparison of the figures in the above tables we find that after exercise Mr. P. showed a slight decrease in physical precision in two of the trials, an increase in one, and no change in two trials.

In the totals the differences were so small as to be almost nil, the loss being but 1.59 per cent.

By a comparison with the previous tests on Mr. P. we find that the normal here of 8.8 shows about 10 per cent increase in precision during interval of two weeks without smoking.

This would tend to intensify the results in the smoking tests, which showed a loss in precision of 38.13 per cent immediately after smoking.

MR. P. SMOKER—TARGET TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind.	Total	Av.	Ind.	Total	Av.
1/18	6,4,3,5,3	21	4.2	4,2,4,4,5	20	4.0
1/19	3,3,3,3,4	16	3.2	3,4,3,4,3	17	3.4
1/21	6,4,4,5,4	23	4.6	3,4,3,4,3	17	3.4
1/22	4,2,2,3,6	17	3.4	4,3,3,4,3	17	3.4
1/26	4,6,4,6,4	24	4.8	4,4,4,4,3	19	3.8
1/28	4,4,5,5,5	23	4.6	4,4,2,3,4	17	3.4
1/30	2,3,4,4,4	17	3.4	3,6,5,5,2	21	4.2
2/2	5,5,4,5,5	24	4.8	4,4,4,4,4	20	4.0
2/10	4,4,5,5,4	22	4.4	4,4,4,5,5	22	4.4
2/11	3,4,4,5,5	21	4.2	4,4,3,4,5	20	4.0
Totals		208	41.6		190	38.0
Averages		20.8	4.16		19	3.8

A study of this table shows that in six out of the ten experiments Mr. P. showed a loss in physical precision, in two experiments (1/19 and 1/30) a slight increase and in the other two tests there was neither a gain nor a loss. The final average of 4.16 before smoking and that of 3.8 after smoking shows a difference of .36 or a loss of 8.65 per cent for this test.

MR. P. SMOKER—TARGET TEST WITH EXERCISE

Date	NORMAL			AFTER EXERCISE		
	Trials	Total	Av.	Trials	Total	Av.
3/2	4,4,4,5,5	22	4.4	6,5,5,5,4	25	5.0
3/3	3,4,4,4,5	20	4.0	4,4,5,5,5	23	4.6
3/8	4,4,5,4,4	21	4.2	4,3,4,5,5	21	4.2
3/9	5,4,3,5,4	21	4.2	5,5,4,4,4	22	4.4
3/10	5,4,6,4,5	24	4.8	4,5,6,5,4	24	4.8
Totals		108	21.6		115	23.0
Averages		21.6	4.33		23	4.6

From this table we discover that exercise had no bad results with the target test; in fact, as in-

licated in the totals, the efficiency in the thrust was increased 6.23 per cent.

Not in any of the trials was loss shown, but an increase in three trials and no change in two.

These results may be due to the fact that the best response is obtained only after a certain amount of "warming up," in all tests involving the larger muscle groups.

When compared with the previous tests, which showed a loss in physical precision of 8.65 per cent after smoking, this may also tend to increase the importance of the results to those interested in physical training.

Tables follow giving a summary and average for each individual and the averages for the groups. This is followed by a statement table and then is given a final table, bringing together the averages of the groups for comparison, particularly with regard to the effect of smoking.

SUMMARY OF TABLES

TABLE I. SMOKERS—BLANK TEST

Results of smoking experiment

Name	Average before smoking	Average after smoking	Difference	Per Cent Diff.
Mr. P.	4.85	6.7	-1.85	-38.13
Mr. R.	5.25	5.86	- .61	-11.61
Mr. S.	5.6	8.2	-2.6	-46.42
Mr. T.	4.5	5.1	- .6	-13.33
Mr. X.	6.05	6.61	- .56	- 9.25
Mr. Y.	8.5	12.65	-4.15	-48.82
Mr. Z.	13.17	15.22	-2.05	-15.56
Totals	47.92	60.34	-12.42	-
Averages	6.854	8.62	- 1.77	-25.96

TABLE II. SMOKERS—BLANK TEST WITH EXERCISE
Results after two weeks interval

Name	Average before exercise	Average after exercise	Difference	Per Cent Diff.
Mr. P.	4.4	4.33	+ .07	+ 1.59
Mr. R.	5.2	5.66	- .46	- 8.84
Mr. S.	5.0	5.93	- .93	-18.6
Mr. T.	4.9	6.135	-1.335	-25.02
Mr. X.	4.1	4.6	- .50	-11.19
Mr. Y.	5.1	7.00	-1.9	-37.25
Mr. Z.	15.3	16.4	-1.1	- 7.18
Totals	44.00	50.055	-6.125	
Averages	6.285	7.150	-0.875	-13.92

TABLE III. SMOKERS—TARGET TEST
Results of smoking experiment

Name	Average before smoking	Average after smoking	Difference	Per Cent Diff.
Mr. P.	4.16	3.8	-0.36	- 8.65
Mr. R.	3.7	3.56	-0.14	- 3.78
Mr. S.	4.12	3.66	-0.46	-11.15
Mr. T.	3.84	3.66	-0.18	- 4.68
Mr. X.	3.68	3.3	-0.38	-10.32
Mr. Y.	4.075	3.725	-0.35	- 8.58
Mr. Z.	4.1	3.66	-0.44	-10.73
Totals	27.675	25.365	-2.31	
Averages	3.953	3.623	- .33	- 8.35

TABLE IV. SMOKERS—TARGET TEST WITH EXERCISE
Results after interval of two weeks

Name	Average before exercise	Average after exercise	Difference	Per Cent Diff.
Mr. P.	4.16	3.8	-0.36	- 8.65
Mr. R.	4.36	4.12	-0.24	- 5.52
Mr. S.	4.04	4.08	+0.04	+ .00
Mr. T.	4.16	3.64	-0.52	-12.5
Mr. X.	3.72	3.88	+0.16	+ 4.30
Mr. Y.	3.84	3.68	-0.16	- 3.31
Mr. Z.	4.00	3.76	-0.24	- 6.00
Totals	28.28	27.776	- .69	
Averages	4.04	3.965	- .098	- 2.41

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TABLE V. NON-SMOKERS—BLANK TEST WITH EXERCISE
Results of non-smoking experiment

Name	Average before exercise	Average after exercise	Difference	Per Cent Diff.
Mr. A.	8.0	8.465	— .465	— 5.81
Mr. B.	5.2	5.266	— .066	— 1.27
Mr. C.	10.4	12.665	—2.265	—21.77
Mr. D.	7.7	6.132	+1.568	+20.36
Mr. E.	9.9	11.86	—1.96	—19.84
Mr. F.	5.3	4.066	+1.234	+23.28
Mr. G.	8.2	8.4	—0.2	— 2.04
Totals	54.7	56.854	—2.154	
Averages	7.814	8.122	— .308	— 3.94

TABLE VI. NON-SMOKERS—BLANK TEST
Results of smoking experiment

Name	Average before smoking	Average after smoking	Difference	Per Cent Diff.
Mr. A.	7.35	8.77	—1.416	—19.25
Mr. B.	5.45	5.56	— .11	— 2.02
Mr. C.	8.25	9.63	—1.38	—16.76
Mr. D.	7.1	8.132	—1.032	—14.53
Mr. E.	5.8	7.932	—2.132	—36.75
Mr. F.	3.8	3.8	0.00	0.00
Mr. G.	6.9	10.4	—3.5	—50.72
Totals	44.65	54.226	—9.570	
Averages	6.38	7.747	—1.367	—21.43

TABLE VII. NON-SMOKERS—TARGET TEST WITH EXERCISE
Results of non-smoking experiment

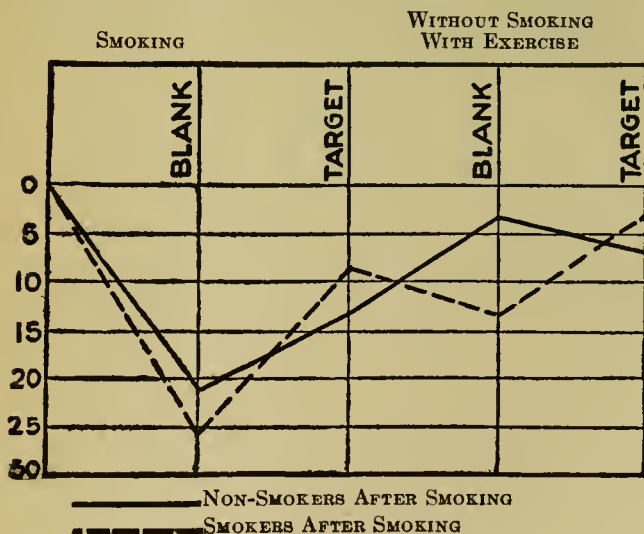
Name	Average before exercise	Average after exercise	Difference	Per Cent Diff.
Mr. A.	3.56	3.60	+0.04	+1.12
Mr. B.	3.8	3.74	—0.16	—4.21
Mr. C.	4.16	3.76	—0.40	—9.61
Mr. D.	4.84	4.4	—0.44	—9.09
Mr. E.	3.92	4.0	+0.08	+2.04
Mr. F.	4.8	4.48	—0.32	—6.66
Mr. G.	4.44	4.04	—0.40	—9.01
Totals	29.520	28.02	—1.60	
Averages	4.217	4.	— .229	—5.43

TABLE VIII. NON-SMOKERS—TARGET TEST
Results of smoking experiment

Name	Average before	Average after	Difference	Per Cent Diff.
Mr. A.	4.5	3.92	— .58	—12.88
Mr. B.	4.59	4.22	— .36	— 7.86
Mr. C.	4.4	3.76	— .64	—15.38
Mr. D.	4.72	3.56	—1.16	—24.57
Mr. E.	3.68	3.22	— .46	—12.5
Mr. F.	4.64	4.2	— .44	— 9.47
Mr. G.	4.32	3.8	— .52	—12.03
Totals	30.85	26.68	—4.16	
Averages	4.405	3.811	— .59	—13.43

The results of the above tables may be briefly shown by the following curves:

AVERAGE PERCENTAGE OF LOSS IN PRECISION



SUMMARY OF INDIVIDUALS

SMOKERS					
Name	Results after smoking			Results after exercise	
	Blank Test	Target Test		Blank Test	Target Test
Mr. P.	Marked Loss	Slight	Loss	Improved	Improved
Mr. R.	Slight	"	"	Loss	Loss
Mr. S.	Marked	"	"	"	Improved
Mr. T.	Slight	"	"	"	Loss
Mr. X.	"	"	"	Improved	Improved
Mr. Y.	Marked	"	"	Loss	"
Mr. Z.	Slight	"	"	"	Loss

NON-SMOKERS					
Mr. A.	Marked Loss	Slight	Loss	Improved	Improved
Mr. B.	Slight	"	"	"	"
Mr. C.	Marked	Marked	"	Loss	"
Mr. D.	"	"	"	Improved	"
Mr. E.	"	Slight	"	"	"
Mr. F.	No difference	"	"	"	"
Mr. G.	Marked loss			"	"

Marked Loss—over 15 per cent.

Slight loss—under 15 per cent.

Improved—means over previous results, not always in actual per cent.

CONCLUSIONS

1. All smokers showed a loss in physical precision immediately after smoking.

2. Five of the seven smokers showed improvement during the interval when not smoking.

3. Smokers showed a greater lack of neuromuscular control after exercise than non-smokers.

4. Non-smokers showed the greatest loss in physical precision after smoking.

5. Non-smokers showed slight gain in precision during smoking tests. This, in the mind of the

writer, is probably due to greater experience with the apparatus.

6. All non-smokers showed improvement in neuro-muscular control after exercise.

7. Some of the subjects in both classes were affected more than others. This was more pronounced in the tests taken with non-smokers.

8. General effect of smoking on the non-smokers also produced other serious results, in some cases physical discomfort.

For those who desire to study the details of the experiments, the individual records are brought together in the appendix.

APPENDIX TO PART III

MR. P. SMOKER—BLANK TEST

For tests on Mr. P., see preceding tables, page 87

MR. R. SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind.			Ind.		
	Score	Tot.	Av.	Score	Tot.	Av.
1/19	3,8	11	5½	9,12,13	34	11.33
1/21	8,12	20	10	7, 5,12	24	8
1/22	7,5	12	6	6, 6, 4	16	5.33
1/26	5,4	9	4½	6, 8, 4	18	6
1/28	6,4	10	5	4, 4, 7	15	5
1/30	6,2	8	4	4, 7, 7	18	6
2/2	6,4	10	5	3, 2, 8	13	4.33
2/4	5,7	12	6	4, 4, 4	12	4
2/11	5,3	8	4	2, 5, 6	13	4.33
2/16	2,1	3	2½	4, 3, 6	13	4.33
Totals		105	52.5		176	58.65
Averages		10.5	5.25		17.6	5.86

Results from this table indicate a difference of .61 in the average scored, or a loss of 11.61 per cent after smoking.

MR. R. SMOKER—BLANK TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind.			Ind.		
	Score	Tot.	Av.	Score	Tot.	Av.
3/8	8,7	15	7.5	8,8,7	23	7.66
3/10	7,3	10	5	3,7,8	18	6
3/19	5,5	10	5	6,3,4	13	4.33
4/20	6,4	10	5	5,6,7	18	6
4/28	5,2	7	3.5	2,5,6	13	4.33
Total		52	26		85	28.33
Average		10.4	5.2		17	5.66

The average score of 5.66 after exercise as compared with 5.2 before shows a loss of 8.84 per cent in precision, which is nearly equal to the loss after smoking.

The normal here after a two weeks' interval without smoking is 5.2 as compared with 5.25 while smoking; which would show that smoking with this man had very little injurious effect, less than 1 per cent.

MR. R. SMOKER—TARGET TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
1/19	2,3,3,4,4	16	3.2	2,2,3,4,2	13	2.6
1/21	4,4,2,3,5	18	3.6	2,3,3,4,4	16	3.2
1/22	3,3,3,3,3	15	3.0	4,2,3,4,3	16	3.2
1/26	3,2,3,4,3	15	3.0	4,4,4,3,4	19	3.8
1/28	5,5,5,3,4	22	4.4	3,3,4,5,4	19	3.8
1/30	3,3,3,3,3	15	3.0	4,6,3,4,3	20	4.0
2/2	3,4,5,4,4	20	4.0	5,3,6,3,3	20	4.0
2/4	3,4,5,4,4	20	4.0	2,4,4,3,4	17	3.4
2/11	5,5,4,4,5	23	4.6	3,4,4,4,3	18	3.6
2/16	4,4,4,4,5	21	4.2	3,4,5,5,3	20	4.0
Total		185	37		178	35.6
Average		18.5	3.7		17.8	3.56

The difference in scores before and after smoking in this test shows a loss of but 3.78 per cent in precision.

MR. R. SMOKER—TARGET TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
3/8	5,4,5,4,5	23	4.6	3,4,4,5,4	20	4.0
3/10	4,6,4,4,5	23	4.4	4,4,5,5,4	22	4.4
3/19	4,6,4,4,5	23	4.6	4,4,5,5,4	22	4.4
4/20	4,4,5,5,4	22	4.4	3,3,4,4,3	17	3.4
4/22	4,3,4,4,4	19	3.8	4,4,5,4,5	22	4.4
Total		109	21.8		103	20.6
Average		21.8	4.36		20.6	4.12

The difference in scores here shows a loss of 5.52 per cent after exercise, which is greater than the loss after smoking.

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But the normal of 4.36 shows an increase in precision during two weeks without smoking of 15.34 per cent, which would indicate that smoking after all prevented the best performance and for our purpose was harmful for Smoker R.

MR. S. SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
1/18	1,4	5	2.5	7,10, 5	22	7.33
1/19	7,10	17	8.5	8, 9,14	31	10.33
1/21	6,6	12	6	10,12,11	33	11
1/22	10,6	16	8	5, 6,12	23	7.33
1/26	6,8	14	7	7, 8, 9	24	8
1/27	4,5	9	4.5	5, 9,10	24	8
1/28	4,2	6	3	7, 8, 6	21	7
1/30	5,4	9	4.5	1, 5, 6	12	4
2/4	8,8	16	8	10, 7,12	29	9.66
2/8	3,5	8	4	6,10,11	27	9
Total		112	56		246	81.65
Average		11.2	5.6		24.6	8.16

With two very small exceptions on Jan. 22 and 30, we find that Mr. S. showed a marked loss in this test. The differences in this table in the total scores show a loss of 46.42 per cent for after smoking, as compared with the tests taken before smoking.

MR. S. SMOKER—BLANK TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
3/2	3,6	9	4.5	11,9,4	24	8
3/3	10,5	15	3	6,3,6	15	5
4/15	3,3	6	7.5	8,7,2	17	5.66
4/20	9,3	12	6.0	3,7,6	16	5.33
4/21	6,2	8	4.0	5,5,7	17	5.66
Total		50	25		89	29.66
Average		10	5		17.8	5.93

The scores here indicate a loss of 18.6 per cent after exercise.

The normal for this series of five experiments, taken after a two weeks' interval without smoking, shows an improvement of 10.7 per cent over the normal taken while still using tobacco.

MR. S. SMOKER—TARGET TEST						
BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
1/18	2,4,3,4,3	17	3.4	2,2,3,3,4	14	2.8
1/19	6,4,5,5,3	23	4.6	4,3,4,4,2	17	3.4
1/21	4,4,4,4,4	20	4.0	4,3,3,4,5	19	3.8
1/22	5,5,5,3,5	23	4.6	4,5,5,2,4	20	4.0
1/26	4,3,5,4,4	20	4.0	4,0,4,4,3	15	3.0
1/27	5,5,4,4,4	22	4.4	5,3,4,6,5	23	4.6
1/28	3,4,4,4,3	18	3.6	4,3,4,3,2	16	3.2
1/30	5,4,4,3,4	20	4.0	4,6,4,3,5	22	4.4
2/4	4,4,5,5,3	21	4.2	4,3,5,3,3	18	3.6
2/8	5,4,3,6,4	22	4.4	3,3,5,3,3	19	3.8
Total		206	41.2		183	36.6
Average		20.6	4.12		18.3	3.66

The difference in scores before and after smoking in this test shows a loss of 11.15 per cent in physical precision.

MR. S. SMOKER—TARGET TEST WITH EXERCISE						
BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
3/2	5,3,4,6,5	23	4.6	5,4,3,5,5	22	4.4
3/3	4,4,4,4,4	20	4.0	4,5,5,5,5	24	4.8
4/15	4,5,4,4,4	21	4.2	5,4,3,4,3	19	3.8
4/20	5,4,3,2,4	18	3.6	4,4,4,3,4	19	3.8
4/21	3,4,3,4,5	19	3.8	3,4,3,3,5	18	3.6
Total		101	20.2		102	20.4
Average		20.2	4.04		20.4	4.08

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The difference in scores after exercise shows a small gain of less than 1 per cent, which for all practical purposes can be neglected.

The normal score of 4.04 without smoking also shows such a very small difference (1.91 per cent) from that taken while smoking, that we conclude the only evil results in this test to be immediately after smoking.

MR. T. SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
1/22	6,3	9	4.5	7,6,3	16	5.33
1/28	7,4	11	5.5	4,7,7	18	6.0
1/30	4,6	10	5.0	6,8,8	22	7.33
2/4	1,6	7	3.5	3,3,5	11	3.66
2/8	4,6	10	5.0	1,4,7	12	4
2/10	6,5	11	5.5	1,5,3	9	3
2/11	1,3	4	4	6,4,5	15	5
2/17	5,5	10	5	5,6,5	16	5.33
2.24	3,3	6	3	3,7,5	15	5
2/25	5,3	8	4	7,4,8	19	6.33
Total		90	45		153	51
Average		9	4.5		15.3	5.1

In this series of experiments Mr. T. lost in physical precision eight out of the ten trials. In the trials of Feb. 8th and 10th a slight increase was registered.

The final average of 5.1 after smoking shows an increase in the number of errors of 13.33 per cent when compared with the average of 4.5 before smoking.

MR. T. SMOKER—BLANK TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
3/30	4,7	11	5.5	7,5,5	17	5.66
3/31	3,7	10	5.0	5,9,8	22	7.33
4/2	5,8	13	6.5	7,6,8	21	7.00
4/6	3,4	7	3.5	9,4,2	15	5.00
4/9	5,3	8	4.0	6,4,7	17	5.66
Total		49	24.5		92	30.65
Average		9.8	4.9		18.4	6.13

The results here show an increase in the number of errors, or a loss of 25.02 per cent in precision after exercise.

By comparison with the previous test we find that there is a loss of 8.88 per cent in precision during interval without smoking, which cannot be accounted for.

MR. T. SMOKER—TARGET TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Tot.	Av.	Ind. Score	Tot.	Av.
1/22	5,3,2,2,3	15	3.0	2,2,3,4,4	15	3.0
1/28	5,2,5,5,4	21	4.2	4,3,3,2,3	15	3.0
1/30	2,4,4,4,3	17	3.4	4,5,5,4,5	23	4.6
2/4	5,3,4,3,5	20	4.0	3,3,4,6,3	19	3.8
2/8	4,5,4,3,4	20	4.0	3,3,4,4,5	17	3.4
2/10	5,4,3,5,3	20	4.0	3,3,5,4,4	19	3.8
2/11	4,3,5,4,4	20	4.0	6,2,3,2,3	16	3.2
2/17	5,3,5,2,4	19	3.8	4,4,3,4,5	20	4.0
2/24	5,3,5,4,3	20	4.0	4,3,2,6,5	20	4.0
2/25	3,5,4,4,4	20	4.0	4,4,4,3,4	19	3.8
Total		192	38.4		183	36.6
Average		19.2	3.84		18.3	3.66

The averages here show a loss of 4.68 per cent after smoking, with the results in the individual

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scores before and after smoking showing a slight loss in six out of the ten trials.

MR. T. SMOKER—TARGET TEST WITH EXERCISE

Date	BEFORE SMOKING			AFTER EXERCISE		
	Ind.			Ind.		
Score	Total	Av.	Score	Total	Av.	
3/30	4,7,2,4,4	21	4.2	3,5,4,4,4	20	4.0
3/31	4,3,4,6,4	21	4.2	4,4,6,3,3	20	4.0
4/2	4,4,4,5,4	21	4.2	2,3,4,3,3	15	3.0
4/6	4,4,4,5,3	20	4.0	3,4,3,3,5	18	3.6
4/8	4,3,5,4,5	21	4.2	4,3,4,3,4	18	3.6
Total	104	20.8		91	18.2	
Average	20.8	4.16		18.2	3.64	

The results here show a loss of 12.5 per cent after exercise.

The normal of 4.16 after two weeks without smoking shows an increase of 8.33 per cent over the normal taken during smoking experiments.

MR. X. SMOKER—BLANK TEST

BEFORE SMOKING				AFTER SMOKING		
	Ind.			Ind.		
Date	Score	Total	Av.	Score	Total	Av.
1/18	3,9	12	6	12,6,12	30	10
1/19	9,9	18	9	11,12,18	41	13.66
1/21	7,11	18	9	19,9,15	43	14.33
1/22	5,5	10	5	1,4,2	7	2.33
1/26	5,9	14	7	4,4,7	15	5
1/27	9,5	14	7	9,6,7	22	7.33
1/28	4,6	10	5	2,2,5	9	3
2/2	2,4	6	3	3,5,4	12	4
2/4	3,3	6	3	8,5,1	14	4.66
Total		108	54		193	64.31
Average		12	6		21.4	7.14

Mr. X. showed a loss of 19.16 per cent in precision after smoking tests. The individual scores

show a slight gain in four of the tests which was more than counteracted by the losses in the other six tests.

MR. X. SMOKER—BLANK TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
4/20	4,0	4	2.0	3,3,5	11	3.66
4/23	2,4	6	3.0	6,6,5	17	5.66
4/26	6,6	12	6	4,3,7	14	4.66
4/27	5,5	10	5	3,2,5	10	3.33
4/28	4,5	9	4.5	3,8,6	17	5.66
Total		41	20.5		69	23
Average		8.2	4.1		13.8	4.6

Here we find a loss of 12.19 per cent in the total averages after exercise.

The normal of 4.1 made after the interval of two weeks without smoking shows a gain of 32.33 per cent in physical precision, showing the decided evil effects on this individual.

MR. X. SMOKER—TARGET TEST

Date						
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	3,4,3,4,5	19	3.8	3,2,3,3,3	14	2.8
1/19	3,2,3,4,3	15	3.0	4,3,4,3,6	20	4.0
1/21	3,4,4,3,3	17	3.4	3,4,2,3,3	15	3.0
1/22	5,3,3,4,4	19	3.8	2,3,4,4,3	16	3.2
1/26	4,3,3,4,6	20	4.0	3,2,5,2,3	15	3.0
1/27	2,3,3,4,3	15	3.0	3,2,5,2,3	15	3.0
1/28	3,3,5,3,5	19	3.8	3,4,3,3,4	17	3.4
2/2	4,3,4,5,4	20	4.0	4,4,4,4,3	19	3.8
2/4	4,3,5,4,4	20	4.0	5,4,4,4,3	20	4.0
2/10	3,3,3,3,4	19	3.8	3,2,4,2,3	14	2.8
Total		184	36.6		165	33
Average		18.4	3.66		16.5	3.3

The averages in this table also show a loss of

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10.32 per cent in precision for Mr. X. after smoking.

MR. X. SMOKER—TARGET TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
4/20	4,3,5,3,3	18	3.6	3,4,4,4,3	18	3.6
4/23	3,4,4,4,4	19	3.8	3,4,6,3,4	20	4.0
4/26	6,3,4,2,4	19	3.8	5,4,4,4,4	21	4.2
4/27	4,4,3,4,5	20	4.0	4,4,4,4,4	20	4.0
4/28	3,4,4,3,3	17	3.4	3,4,5,3,3	18	3.6
Total		93	18.6		97	19.4
Average		18.6	3.72		19.4	3.88

The trials after exercise in the target test show an increase of 4.30 per cent for Mr. X., as for most of the other subjects in this test.

The normal of 3.72, taken after smoking had been discontinued for two weeks, shows an increase of only 1.08 per cent, which in itself is not much, but when considered with the results in the Blank Test tends to confirm the decided evil effects found in that test.

MR. Y. SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	4,5	9	4.5	17,22,19	58	19.33
1/21	16,12	28	14	14,14,12	40	13.33
1/27	7,15	22	11	11,11,11	33	11
1/28	11,13	24	12	10,7,18	35	11.66
1/30	6,7	13	6.5	13,10,17	40	13.33
2/4	2,8	10	5	9,12,14	35	11.66
2/19	8,6	14	7	5,10,19	34	11.33
2/25	6,10	16	8	8,8,12	28	9.33
Total		136	68		303	100.97
Average		17	8.5		37.88	12.62

Owing to normal work only eight smoking experiments could be completed. On Mr. Y., with the exception of one time, the trials in this test show a decided loss, the general averages showing a loss of 48.52 per cent. Mr. Y. was perhaps the most consistent of all the smokers.

MR. Y. SMOKER—BLANK TEST WITH EXERCISE
BEFORE EXERCISE AFTER EXERCISE

Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
4/15	7,9	16	8	11,9,8	28	9.33
4/26	3,3	6	3	7,13,7	27	9
4/28	4,4	8	4	5,9,6	20	6.66
5/3	7,5	12	6	5,7,5	17	5.66
5/4	6,3	9	4.5	8,1,4	13	4.33
Total		51	25.5		105	35
Average		10.2	5.1		21	7

The trials after exercise show a loss of 37.25 per cent, which would tend to show the unstable condition of the neuro-muscular system, even after smoking had been discontinued for two weeks.

The normal at this time has greatly improved, as is shown by the 40 per cent increase in physical precision registered during the test.

These differences of 48.52 per cent loss directly after smoking with an improvement of 40 per cent after exercise are the greatest recorded on any of the smokers.

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MR. Y. SMOKER—TARGET TEST

BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	3,3,4,4,3	17	3.4	4,4,4,4,3	19	3.8
1/21	5,4,5,4,3	21	4.2	3,3,5,3,4	18	3.6
1/26	3,4,5,4,3	19	3.8	3,4,5,5,3	20	4.0
1/28	4,5,4,5,3	21	4.2	3,3,4,5,4	19	3.8
1/30	6,3,5,3,5	22	4.4	3,5,5,3,3	19	3.8
2/4	4,5,5,4,4	22	4.4	4,2,4,4,3	17	3.4
2/19	3,4,4,4,5	20	4.0	3,4,3,4,4	18	3.6
2/25	4,3,5,5,4	21	4.2	3,5,4,4,3	19	3.8
Total		163	32.6		149	29.8
Average		20.38	4.075		18.65	3.725

The loss in physical precision registered after smoking in this test was 8.58 per cent as compared with the normal.

MR. Y. SMOKER—TARGET TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
4/15	3,4,4,2,4	17	3.4	3,4,4,4,3	18	3.6
4/26	4,3,4,4,4	19	3.8	4,3,3,3,3	16	3.2
4/28	5,5,3,4,3	20	4.0	4,3,4,4,4	19	3.8
5/3	4,5,5,4,3	21	4.2	6,5,4,4,3	22	4.4
5/4	4,3,4,3,5	19	3.8	4,4,3,3,3	17	3.4
Total		96	19.2		92	18.4
Average		19.2	3.84		18.4	3.68

This test also shows a loss of 4.16 per cent after exercise, which tends further to show the unstable condition of the neuro-muscular system.

The normal after these two weeks without smoking has also decreased and shows a further loss of 3.31 per cent.

When considered together, the results found

in this set of tables show the most decided losses in physical precision found among any of the smokers. As has been stated Mr. Y. was also the heaviest of the regular smokers.

MR. Z. SMOKER—BLANK TEST

BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	6,10	16	8	16,14,18	48	16
1/27	10,10	20	10	12,15,12	39	13
2/8	13,12	25	12.5	13,15,16	44	14.66
2/10	16,18	34	17	16,15,15	46	15.33
2/16	19,16	35	17.5	16,16,19	51	17
2/19	15,13	28	14	14,16,16	46	15.33
Total		158	79		274	91.33
Average		26.33	13.166		45.66	15.22

Outside engagements also interfered with Mr. Z.'s tests, and but six experiments could be completed. The average number of errors, 13.166 before smoking and 15.221 after smoking were the highest recorded against any man. The percentage of increase after smoking was 15.6.

MR. Z. SMOKER—BLANK TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
3/2	13,21	34	17	21,23,20	64	21.33
3/8	20,12	32	16	19,14,17	50	16.66
3/10	18,15	33	16.5	20,14,14	48	16
4/20	13,15	28	14	16,13,15	44	14.66
4/21	12,14	26	13	14,16,10	40	13.33
Total		153	76.5		246	82
Average		30.6	15.3		49.2	16.4

After an interval of two weeks without smok-

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ing, these records increased to 15.3 normal and 16.4 after exercise. The percentage of increase after exercise was 7.18.

The increase in the normal after two weeks interval to 15.3 shows a loss of 15.44 per cent over the normal of 13.166 while smoking.

In this case the high total number of errors, with a further increase after smoking had been discontinued, was probably due to the normal neuro-muscular control rather than the influence of the tobacco.

MR. Z. SMOKER—TARGET TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	3,4,4,4,4	19	3.8	1,4,4,5,5	19	3.8
1/27	4,3,4,4,3	18	3.6	4,4,3,3,4	18	3.6
2/8	4,4,5,4,5	22	4.4	4,3,4,5,4	20	4.0
2/10	5,4,4,4,3	20	4.0	4,3,4,3,3	17	3.4
2/16	6,4,4,6,3	23	4.6	4,3,5,3,3	18	3.6
2/19	3,5,4,4,4	20	4.0	4,3,4,3,4	18	3.6
Total		22	24.4		110	22
Average		20.5	4.06		18.33	3.66

The averages for this test show a loss after smoking of 10.73 per cent in physical precision.

MR. Z. SMOKER—TARGET TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
3/2	3,5,4,3,4	19	3.8	3,3,4,3,5	20	4.0
3/8	4,4,3,6,4	21	4.2	5,3,3,4,5	20	4.0
3/10	4,3,5,6,4	22	4.4	3,4,4,4,4	19	3.8
4/20	3,4,4,4,4	19	3.8	3,4,4,2,3	16	3.2
4/21	4,4,3,3,5	19	3.8	3,4,3,4,5	19	3.8
Total		100	20		94	18.8
Average		20	4		18.8	3.76

The averages in this test of 3.76 for trials after exercise show a further loss in muscular control of 6 per cent over normal taken immediately before.

The normal taken after two weeks without smoking shows practically no improvement over that taken while smoking, so that when considered with the results in the Blank Test these differences would appear to be due to a lack of neuro-muscular control rather than the immediate effects of smoking. Mr. Z. had never been a very heavy smoker at any time of his life.

MR. A. NON-SMOKER—BLANK TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	4,11	15	7.5	4,12,7	23	7.66
1/21	9,13	22	11	11,13,10	34	11.33
1/26	8,12	20	10	10,9,11	30	10
1/27	5,4	9	4.5	7,5,6	18	6
1/28	6,8	14	7	7,8,7	22	7.33
Total		80	40		127	42.33
Average		16	8		25.4	8.46

With all non-smokers five experiments were first taken to obtain a normal score under ordinary conditions in both tests, without smoking and with exercise, which could be compared with tests taken after smoking.

The normal average for Mr. A. was 8.00. The average taken after exercise was 5.465, the difference being so slight as to be nil for all practical purposes.

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MR. A. NON-SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind.	Total	Av.	Ind.	Total	Av.
1/28	12,10	22	11	10,11,14	35	11.66
2/2	7,8	15	7.5	9,9,12	30	10
2/4	8,8	16	8	10,7,7	24	8
2/8	6,4	10	5	10,8,10	28	9.33
2/11	10,5	15	7.5	11,5,8	24	8
2/16	5,9	14	7	5,8,7	20	6.66
2/17	5,6	11	5.5	8,8,9	25	8.33
2/4	6,6	12	6	6,5,4	15	5
2/25	7,9	16	8	10,7,13	30	10
3/2	8,8	16	8	13,8,11	32	10.66
Total		147	73.5		263	87.66
Average		14.7	7.35		26.3	8.76

In the case of the non-smoker this becomes the smoking test—ten experiments.

In seven out of the ten experiments, a decided loss, in two a slight gain, and one with no change are the results obtained after smoking.

The total averages show a loss of 19.26 per cent in physical precision after smoking.

MR. A. NON-SMOKER—TARGET TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind.	Total	Av.	Ind.	Total	Av.
1/18	1,4,3,2,3	13	2.6	2,2,3,3,3	13	2.6
1/21	4,2,1,3,4	14	2.8	3,2,4,3,3	15	3
1/26	4,4,4,3,4	19	3.8	2,3,5,5,5	20	4
1/27	4,3,4,5,5	21	4.2	4,5,4,4,4	21	4.2
1/28	4,4,5,5,4	22	4.4	4,3,5,5,4	21	4.2
Total		89	17.8		90	18
Average		17.8	3.56		18	3.60

We also find in the target test that the difference between the normal of 3.56 and the test

taken after exercise, 3.60, is so small that for all practical purposes it can be neglected.

MR. A. NON-SMOKER—TARGET TEST

BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/28	4,5,4,3,4	20	4	3,4,4,3,3	17	3.4
2/2	7,8,2,2,3	22	4.4	4,4,4,4,3	19	3.8
2/4	5,3,4,6,6	24	4.8	5,4,5,5,4	23	4.6
2/8	4,6,5,4,4	23	4.6	4,3,3,3,4	17	3.4
2/11	5,6,4,4,4	23	4.6	6,3,4,5,4	22	4.4
2/16	4,4,4,4,4	20	4	3,6,5,3,3	20	4
2/17	5,5,4,4,4	22	4.4	3,4,3,4,3	17	3.4
2/24	5,3,6,5,5	24	4.8	4,5,5,4,4	22	4.4
2/25	6,5,4,5,5	25	5	3,2,4,4,4	17	3.4
3/2	4,6,3,5,4	22	4.4	4,5,5,4,4	22	4.4
Total		225	45		196	39.2
Average		22.5	4.5		19.6	3.92

In this test we also find a great improvement in the normal taken first, when compared with that taken during the smoking test, which is also due to greater experience in handling the foils.

When compared with the average made after smoking, this shows a loss of 12.88 per cent in physical precision.

MR. B. NON-SMOKER—BLANK TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/22	8,6	14	7	2,8,3	13	4.33
1/27	5,2	7	3.5	3,7,5	15	5
1/28	4,5	9	4.5	3,6,6	15	5
1/29	4,4	8	4	4,5,9	18	6
1/30	7,7	14	7	6,6,6	18	6
Total		52	26		79	26.33
Average		10.4	5.2		15.8	5.266

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The normal here of 5.2 when compared with the average after exercise, 5.266, shows practically no difference, and in this case can be neglected.

MR. B. NON-SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
2/11	1,9	10	5	10,5,6	21	7
2/16	6,6	12	6	4,6,4	14	4.66
2/17	3,5	8	4	9,5,3	17	5.66
2/19	3,5	8	4	5,2,6	13	4.33
2/24	3,7	10	5	2,5,3	10	3.33
2/25	9,3	12	6	6,4,9	19	6.33
3/2	10,6	16	8	5,8,8	21	7
3/3	3,3	6	3	3,2,4	9	3
3/4	6,6	12	6	3,3,9	15	5
Total		94	47		139	46.33
Average		10.4	5.2		15.4	5.15

In this series of experiments Mr. B. made an actual increase in his four out of the ten trials after smoking, and one was without change. The difference in the averages was very small, showing a loss of only 2.12 per cent in physical precision after smoking.

MR. B. NON-SMOKER—TARGET TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/22	3,4,4,3,4	18	3.6	6,2,4,3,3	17	3.4
1/27	3,2,2,3,5	15	3.	4,3,2,4,3	17	3.4
1/28	5,4,2,2,4	17	3.4	4,4,4,3,3	18	3.6
1/29	4,3,4,3,4	18	3.6	3,5,4,4,3	19	3.8
1/30	4,5,5,6,5	25	5.	4,5,5,4,3	21	4.2
Total		93	18.6		91	18.4
Average		18.6	3.72		18.2	3.68

In this test the percentage of loss after exercise is barely more than 1 per cent and can be neglected.

MR. B. NON-SMOKER—TARGET TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
2/4	6,5,5,5,4	25	5.0	6,6,5,4,3	24	4.8
2/11	4,4,4,4,4	20	4.0	3,4,3,5,5	20	4.0
2/16	5,5,6,6,5	27	5.4	5,3,4,4,5	21	4.2
2/17	5,4,4,4,3	20	4.0	3,4,5,4,4	20	4.0
2/19	5,5,5,5,4	24	4.8	2,4,4,3,4	17	3.4
2/24	5,4,3,5,4	21	4.2	5,5,5,5,5	25	5
2/25	4,5,5,4,3	21	4.2	4,4,3,3,4	18	3.6
3/2	4,4,5,5,4	22	4.4	5,4,4,6,5	24	4.8
3/3	4,4,5,5,5	23	4.6	5,4,4,6,5	24	4.8
3/4	4,4,4,6,5	23	4.6	5,4,5,6,3	23	4.6
Total		229	45.2		211	42.2
Average		22.9	4.52		21.1	4.22

The normal in this case also shows an increase of 20.52 per cent over that found in the five experiments, due no doubt to greater experience in handling the foil.

The average after smoking of 4.22 shows a small loss of 7.86 per cent in precision. All results considered, smoking seemingly had very little effect on precision in the case of Mr. B.

MR. C. NON-SMOKER—BLANK TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/19	11,11	22	11	17,13,14	44	14.66
1/21	9,12	21	10.5	15,18,13	46	15.33
1/22	16,12	28	14	14,9,10	33	11
1/26	10,6	16	8	16,9,10	35	11.66
1/27	10,9	19	9.5	10,9,13	32	10.66
Total		106	53		190	63.33
Average		21.2	10.6		38	12.66

The results here show a normal of 12.665, an average number of errors after exercise of 21.77 per cent, showing an increase of 20.36 per cent in precision after exercise.

MR. C. NON-SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind.			Ind.		
	Score	Total	Av.	Score	Total	Av.
1/28	6,6	12	6	7,5,14	26	8.66
1/30	9,7	16	8	9,8,6	23	7.66
2/2	4,3	7	3.5	9,11,7	27	9
2/4	7,11	18	9	12,7,14	33	11
2/10	10,8	18	9	10,8,7	25	8.33
2/11	12,12	24	12	7,9,14	30	10
2/16	10,9	19	9.5	13,7,6	26	8.66
2/17	7,11	18	9	6,6,12	24	8
2/25	8,10	18	9	6,13,10	29	9.66
3/2	9,6	15	7.5	12,12,22	46	15.33
Total		165	82.5		289	96.33
Average		16.5	8.25		28.9	9.63

The normal of 8.25 shows an increase in precision of 20.67 per cent over normal, which is probably due to greater experience with the foil rather than any effect of the tobacco.

The result of the averages taken directly after smoking shows a loss of 16.76 per cent. In this test Mr. C. appeared very erratic, showing a gain in five of the experiments and a loss in the other five, the losses exceeding the gains by 1.383.

MR. C. NON-SMOKER—TARGET TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	
1/19	3,4,4,4,5	20	4	3,3,4,2,4	16	3.2
1/21	4,4,3,5,4	20	4	4,4,4,3,3	18	3.6
1/22	3,3,4,6,4	20	4	3,4,3,4,4	18	3.6
1/26	3,3,4,6,5	21	4.2	3,4,5,5,4	21	4.2
1/27	5,3,5,4,5,	23	4.6	4,4,4,5,4	21	4.2
Total		104	20.8		94	18.8
Average		10.4	4.16		18.8	3.76

The normal here is 4.16 and the average after exercise 3.76, showing a loss in physical precision of 9.61 per cent.

MR. C. NON-SMOKER—TARGET TEST

BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/28	4,3,4,5,5	21	4.2	6,4,3,3,4	20	4
1/30	4,3,4,4,4	19	3.8	3,6,5,5,4	23	4.6
2/2	4,5,6,4,5	24	4.8	2,3,5,5,4	19	3.8
2/4	4,5,6,6,6	27	5.4	2,4,4,3,4	17	3.4
2/10	4,4,4,4,4	20	4	3,4,3,3,5	18	3.6
2/11	4,4,4,5,3	20	4	1,3,4,2,2	12	2.4
2/16	4,4,3,5,5	21	4.2	3,3,5,4,4	19	3.8
2/17	6,4,4,3,4	21	4.2	3,4,4,4,5	20	4
2/25	6,3,4,6,5	24	4.8	2,4,5,4,3	18	3.6
3/2	4,5,4,6,4	23	4.6	4,5,4,4,5	22	4.4
Total		220	44		188	37.6
Average		22	4.4		18.8	3.76

In this test the normal, 4.4, shows an increase in precision over the normal of 5.76 per cent. The individual experiments, with one exception, show a loss in every case, the average being 3.76, giving a loss of 15.38 per cent after smoking.

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MR. D. NON-SMOKER—BLANK TEST WITH EXERCISE

Date	BEFORE EXERCISE			AFTER EXERCISE		
	Ind.			Ind.		
	Score	Total	Av.	Score	Total	Av.
1/22	12,14	26	13	6,10,5	21	7
1/26	4, 5	9	4.5	6,6,5	17	5.66
1/28	4, 4	8	4	5,4,6	15	5
2/2	8, 6	14	7	4,6,7	17	5.66
2/4	10,10	20	10	10,6,6	22	7.33
Total		77	38.5		92	30.66
Average		15.4	7.7		18.4	6.132

The results here show a normal of 7.7 and an average number of errors after exercise of 6.132, showing an increase of 20.36 per cent in precision after exercise.

MR. D. NON-SMOKER—BLANK TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind.			Ind.		
	Score	Total	Av.	Score	Total	Av.
2/8	9,7	16	8	11,6,7	24	8
2/11	9,9	18	9	9,7,8	24	8
2/17	7,6	13	6.5	8,8,13	29	9.66
3/3	7,7	14	7	9,7,7	23	7.66
3/30	3,7	10	5	12,4,6	22	7.33
Total		71	35.5		122	40.66
Average		14.2	7.1		24.4	8.13

With the exception of the first experiment we find a decided loss in accuracy throughout this test. The average of 8.132 after smoking shows a loss of 14.53 per cent in physical precision.

Mr. D. seemed to enjoy the first cigar, but generally found that the second was too much.

It may be significant to note that no loss in precision was registered until the second smoking experiment on Feb. 11th.

MR. D. NON-SMOKER—TARGET TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/22	6,5,5,5,5	26	5.2	6,5,4,4,5	24	4.8
1/26	3,6,4,5,6	24	4.8	6,4,5,4,4	23	4.6
1/28	4,5,4,4,5	22	4.4	3,3,4,4,5	19	3.8
2/2	6,4,5,4,4	23	4.6	3,5,4,5,4	21	4.2
2/4	6,5,4,5,6	26	5.2	5,6,5,3,4	23	4.6
Total		121	24.2		110	22
Average		24.2	4.84		22	4.4

The average of 4.4 after exercise shows a loss of 9.09 per cent over the normal of 4.84.

MR. D. NON-SMOKER—TARGET TEST

BEFORE SMOKING				AFTER SMOKING		
Date	Ind Score	Total	Av.	Ind. Score	Total	Av.
2/8	5,4,4,6,4	23	4.6	4,4,4,4,4	20	4
2/11	4,6,6,5,4	25	5	2,5,4,4,4	19	3.8
2/17	5,3,4,5,4	21	4.2	3,3,3,4,3	16	3.2
3/3	4,3,5,6,3	23	4.6	3,3,5,4,4	19	3.8
3/30	4,6,5,6,5	26	5.2	3,3,3,4,2	15	3
Total		118	23.6		89	17.8
Average		23.6	4.72		17.8	3.56

In this test Mr. D. showed a decided loss in every experiment. The average of 3.56 after smoking shows a loss of 24.57 per cent in physical precision.

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MR. E. NON-SMOKER—BLANK TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	10,20	30	15	15,21,20	56	18.66
1/30	13,10	23	11.5	13,15,12	40	13.33
2/2	6,12	18	9	10,12,10	32	10.66
2/4	10,8	18	9	8,10,16	34	11.33
2/8	6,4	10	5	7,4,4	15	5
Total		99	49.5		178	59
Average		19.8	9.9		35.6	11.80

The tables here show a normal of 9.9 and an average loss of 19.19 per cent in physical precision.

MR. E. NON-SMOKER—BLANK TEST

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
2/19	6,8	14	7	13,7,4	24	8
3/8	12,6	18	9	6,13,8	27	9
4/16	4,5	9	4.5	5,9,9	23	7.66
4/21	8,6	14	7	8,10,11	29	9.66
4/24	1,2	3	1.5	3,6,7	16	5.33
Total		58	29		119	39.65
Average		11.6	5.8		23.6	7.93

The normal of 5.8 in this table shows an improvement of 31.31 per cent over normal, probably due to greater experience.

Each individual experiment shows a loss in physical precision and the average score of 7.932 gives a loss of 36.75 per cent for the entire test.

MR. E. NON-SMOKER—TARGET TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/18	2,3,3,4,4	16	3.2	2,4,3,5,3	17	3.4
1/30	5,5,4,4,4	22	4.4	4,5,4,3,5	21	4.2
2/2	4,4,4,4,6	22	4.4	4,2,6,4,5,	21	4.2
2/4	4,4,4,4,7	23	4.6	5,5,3,4,4	21	4.2
2/8	3,3,3,3,3	15	3	6,3,4,3,4	20	4.0
Total		98	19.6		100	20
Averages		19.6	3.92		20	4

We here have a normal of 3.92 with an average score 4.0 after exercise, showing an increase of 2.04 per cent for the test.

MR. E. NON-SMOKER—TARGET TEST
BEFORE SMOKING

BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
2/19	3,3,3,4,4	17	3.4	3,2,4,3,2	14	2.8
3/8	2,2,5,4,4	17	3.4	4,3,3,4,3	17	3.4
4/16	3,3,4,5,5	20	4.0	2,3,2,3,3	13	2.6
4/21	4,4,3,3,3	17	3.4	3,5,6,3,3	20	4
4/24	3,4,4,6,4	21	4.2	3,6,3,2,3	17	3.4
Total		92	18.4		81	16.2
Average		18.4	3.68		16.2	3.24

The results here give a normal of 3.68 and an average score after smoking of 3.24. The loss in physical precision for this test is 12.5 per cent.

MR. F. NON-SMOKER—BLANK TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/19	4,5	9	4.5	7,5,4	16	5.33
1/27	9,7	16	8	5,4,4	13	4.33
1/28	7,6	13	6.5	4,2,3	9	3
2/9	3,3	6	3	2,5,4	11	3.66
2/10	4,5	9	4.5	4,3,5	12	4
Total		53	26.5		61	20.33
Average		10.6	5.3		12.2	4.066

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The result of observation in this test gives a normal of 5.3 and an average of 4.066 for number of errors after exercise. This gives an increase in precision of 23.28 per cent after exercise.

MR. F. NON-SMOKER—BLANK TEST

BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
2/11	3,4	7	3.5	4,3,5	12	4
2/17	2,3	5	2.5	3,3,1	7	2.33
3/3	3,1	4	2	1,3,4	8	2.66
4/2	4,4	8	4	6,5,4	15	5
4/6	7,7	14	7	3,3,9	15	5
Total		38	19		57	19
Average		7.6	3.8		10.4	3.8

The tables here show the score before and after smoking to be the same, which means that there was no immediate change directly after smoking. But this normal of 3.8 when compared with the normal of 5.3 in Form I, taken the week before Mr. F. started to smoke, shows a decrease in precision of 28.30 per cent.

MR. F. NON-SMOKER—TARGET TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/19	4,3,5,5,4	21	4.2	4,4,4,3,4	19	3.8
1/27	6,3,6,6,6	27	5.4	4,4,5,5,5	23	4.6
1/28	5,4,3,4,5	21	4.2	5,4,5,5,6	25	5
2/9	5,5,5,6,6	27	5.4	3,4,6,5,5	23	4.6
2/10	6,4,5,5,4	24	4.8	5,6,4,3,4	22	4.4
Total		120	24		112	22.4
Average		24	4.8		22.4	4.48

We here have a normal of 4.8 with an average score of 4.48 after exercise, showing a loss of 6.66 per cent for this test.

MR. F. NON-SMOKER—TARGET TEST						
BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
2/11	5,4,5,5,5	24	4.8	4,5,4,5,4	22	4.4
2/17	5,4,5,5,5	24	4.8	4,4,5,5,4	22	4.4
3/3	4,5,5,5,4	23	4.6	4,5,4,6,4	23	4.6
4/2	5,4,4,5,4	22	4.4	4,3,3,4,3	17	3.4
4/6	4,5,6,4,4	23	4.6	4,4,3,5,5	21	4.2
Total		116	23.2		105	21
Average		23.2	4.64		21	4.2

The tables here give a normal 4.64 and an average after smoking of 4.2, resulting in a loss of 9.47 per cent.

MR. G. NON-SMOKER—BLANK TEST WITH EXERCISE						
BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/21	13,14	27	13.5	12,13,12	37	12.33
1/22	10,12	22	11	9,4,8	21	7
1/26	6,6	12	6	10,8,12	30	10
2/9	4,7	11	5.5	8,6,7	21	7
2/10	4,6	10	5	3,6,8	17	5.66
Total		82	41		126	42
Average		16.4	8.2		25.2	8.4

The normal here of 8.2 and average score after exercise of 8.4 shows an increase of 2.04 per cent after exercise.

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MR. G. NON-SMOKER—BLANK TEST

BEFORE SMOKING				AFTER SMOKING		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
2/17	8,2	10	5	10,10,8	28	9.33
3/3	2,8	10	5	5,8,7	20	3.66
3/31	7,8	15	7.5	9,8,8	25	8.33
4/2	13,8	21	10.5	16,15,13	44	14.66
4/6	6,7	13	6.5	13,13,13	39	13
Total		69	34.5		156	49
Average		13.8	6.9		31.2	9.8

Every individual observation here shows a marked decrease in precision. The total average of 9.8 after smoking when compared with the normal of 6.9 shows a decrease of 42.03 per cent.

After the first experiment Mr. G. refused to smoke more than one cigar, owing to the nauseating effect they produced.

MR. G. NON-SMOKER—TARGET TEST WITH EXERCISE

BEFORE EXERCISE				AFTER EXERCISE		
Date	Ind. Score	Total	Av.	Ind. Score	Total	Av.
1/21	4,4,3,6,5	22	4.4	3,3,3,4,2	15	3
1/22	3,4,4,5,5	21	4.2	4,3,4,5,4	20	4
1/26	6,3,5,4,5	23	4.6	3,5,4,4,5	21	4.2
2/9	5,5,4,4,4	22	4.4	5,4,4,3,5	21	4.2
2/10	4,4,4,6,5	23	4.6	5,6,6,4,3	24	4.8
Total		111	22.2		101	20.2
Average		22.2	4.44		20.2	4.04

The normal here of 4.44 when compared with the average of 4.04 registered after exercise shows an increase of 9 per cent in precision.

MR. G. NON-SMOKER—TARGET TEST

Date	BEFORE SMOKING			AFTER SMOKING		
	Ind.	Total	Av.	Ind.	Total	Av.
2/17	4,5,4,4,4	21	4.2	4,3,4,3,4	18	3.6
3/3	4,5,4,5,4	22	4.4	5,5,4,4,4	22	4.4
3/31	3,6,4,5,4	22	4.4	5,4,3,3,3	18	3.6
4/2	5,4,3,5,6	23	4.6	3,5,4,3,4	19	3.8
4/6	4,4,4,4,4	20	4	3,4,3,4,4	18	3.6
Total		108	21.6		95	19
Average		21.6	4.32		19	3.8

With one exception where there was no change, a loss was registered in each experiment. The results give a normal of 4.32 and an average after smoking of 3.8, showing a loss of 12.03 per cent in physical precision after smoking.

These results would further tend to intensify the evils found in the Blank Test, especially since they are produced after the use of only one cigar.

PART IV

THE EFFECTS OF SMOKING ON ACCURACY IN BASEBALL PITCHING

Experimental Work by

WILLIAM A. LANG

International Young Men's Christian Association College,
Springfield, Mass., 1916

IV

THE EFFECTS OF SMOKING ON ACCURACY IN BASEBALL PITCHING

The results of the precision studies by Blickley suggested the desirability of studying other gross muscular coordinations. If the accuracy of lunging at a target with a fencing foil is disturbed by smoking, then many of our muscular coordinations in practical and industrial life, as well as in our sports, must be affected. We are particularly interested, however, in boys and there is probably no activity dearer to the American boy's heart than throwing a baseball. This study was of peculiar interest to Mr. Lang, as he was himself a baseball pitcher and a smoker. It may at least be said that he was not anxious to secure the results which developed.

The smoking was done in the smoking laboratory used for the other experiments, and the throwing was done in the gymnasium beneath. Twelve men were chosen, smokers and non-smokers, for the experiments, all of them ball players. Official league baseballs were used. The target was a padded block, five feet square, with

a bull's eye one foot in diameter, surrounded by concentric circles six inches apart. This was suspended at such a height that the bull's eye would be approximately at the height of an ordinary man's shoulder. The distance of the throw was sixty feet. An outline of the method of procedure for each test follows:

OUTLINE OF PROCEDURE

TEST A (One Cigar)

1. Arrival at the gymnasium about 6:30 P. M.
2. Three trial throws at the target, not recorded.
3. Record ten throws at the target, distance 60 ft.
4. Retire to a special room to smoke.
5. Smoke *one* cigar in thirty minutes.
6. Return to gymnasium about 7:15 P. M.
7. Three trial throws at the target, not recorded.
8. Record ten throws at the target, distance 60 ft.

TEST B (Two Cigars)

1. Same as in Test A.
2. No trial throws at the target.
3. Same as in Test A.
4. Same as in Test A.
5. Smoke *two* cigars in sixty minutes.

6. Return to the gymnasium about 7:30 P. M.
7. No trial throws at the target.
8. Same as in Test A.

TEST C (No Smoking)

1. Arrival at the gymnasium about 6:30 P. M.
2. Three trial throws at the target, distance 60 ft.
3. Record ten throws at the target.
4. Thirty-minute interval.
5. Three trial throws at the target.
6. Record ten throws at the target.

METHOD OF SCORING BALLS THROWN AT THE TARGET

1. 5 points if the ball hits the bull's-eye.
2. 4 points if the ball hits the inner circle.
3. 3 points if the ball hits the middle circle.
4. 2 points if the ball hits the outer circle.
5. 1 point if the ball hits outside the outer circle.
6. No points if the ball fails to hit the target.

STYLE OF THROWING THE BALL AT THE TARGET

1. Fast straight balls are requested.
2. Any windup or delivery may be used.
3. Mat used to prevent slipping while throwing.

The following is given to illustrate the record of the tests taken on one day, for Test A. The complete set of daily records will be found in the

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appendix to Part IV. A sample is also given of the records of each individual man. These also appear in the appendix.

TEST A—(One cigar) MONDAY APRIL 10, 1916

	Throws										Totals
	1	2	3	4	5	6	7	8	9	10	
Mr. M.	1	3	4	1	3	1	3	3	3	4	27
Mr. E.	4	4	4	2	3	1	2	3	5	1	29
Mr. P.	3	5	4	1	2	1	4	3	4	3	30
Mr. F.	4	4	5	3	3	4	3	4	3	3	36
Mr. A.	2	4	4	3	4	2	3	5	5	3	35
Mr. B.	5	3	1	3	3	4	2	3	1	2	27
Mr. C.	4	3	3	5	1	3	4	4	1	3	31

The above scores were made before smoking.

The following scores were made after smoking one cigar.

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	3	1	2	3	3	2	1	5	5	1	26
Mr. E.	3	4	5	3	2	3	1	5	4	3	33
Mr. P.	1	3	3	1	3	3	1	1	3	1	20
Mr. F.	0	2	5	4	4	3	3	3	3	3	30
Mr. A.	3	1	3	2	1	4	5	4	3	2	28
Mr. B.	3	3	4	1	3	5	3	0	1	5	28
Mr. C.	3	2	4	1	2	1	0	4	0	1	18

The average scores made before smoking are 30.71

The average scores made after smoking are 26.14

There is a decrease after smoking of 4.57

INDIVIDUAL RECORD OF Mr. M.—GIVING TOTALS ONLY

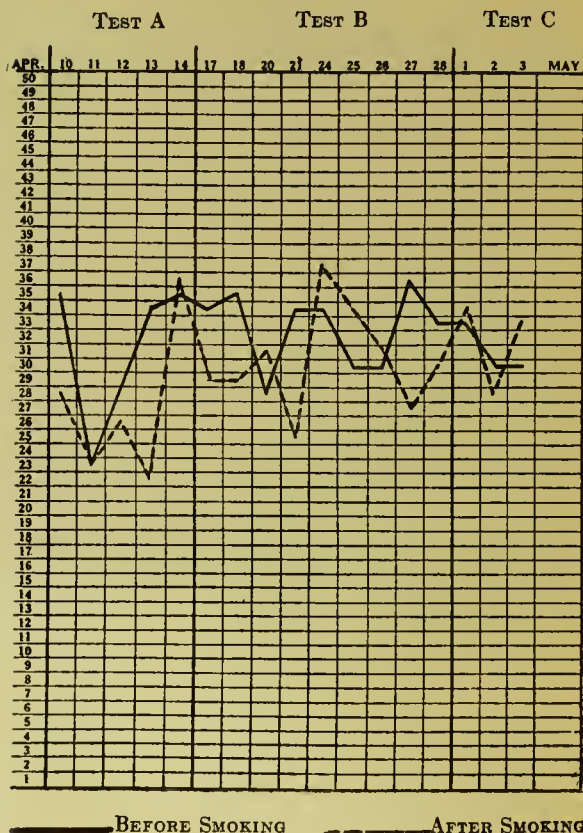
Date	Test	Before Smoking	After Smoking	Loss	Gain
4-10-16	A	27	26	1	
4-11-16	A	32	25	7	
4-12-16	A	34	25	9	
4-13-16	A	25	27		2
4-14-16	A	35	27	8	
4-17-16	B	35	30	5	
4-18-16	B	33	27	6	
4-20-16	B	35	25	10	
4-21-16	B	34	23	11	
4-24-16	B	30	27	3	
4-25-16	B	39	29	10	
4-26-16	B	31	27	4	
4-27-16	B	25	24	1	
4-28-16	B	32	27	5	

		Before Delay	After Delay	
5-1-16	C	26	28	2
5-2-16	C	30	31	1
5-3-16	C	30	36	6

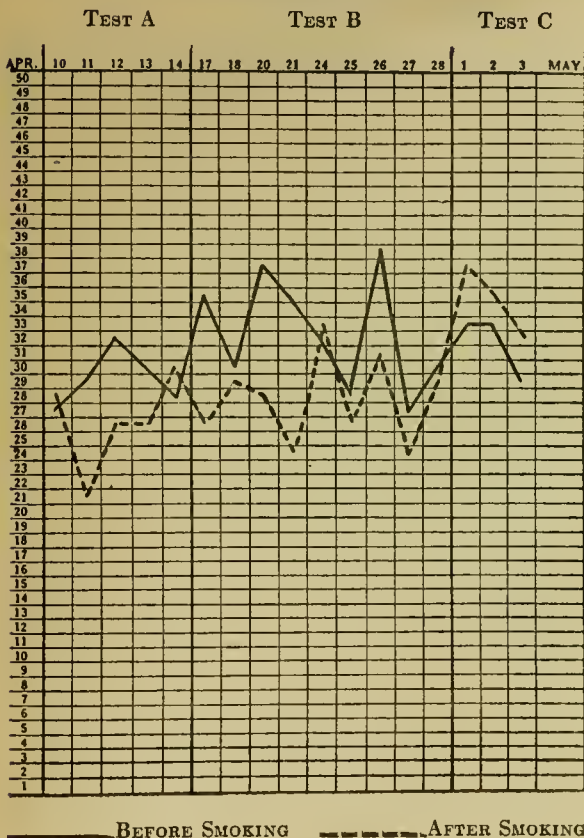
Mr. M. is a baseball player, having had considerable experience as a pitcher. He smokes from ten to twenty cigarettes a day and in our comparisons is therefore termed a smoker. During these experiments he was requested to refrain from using cigarettes at any time, and to use only the cigars prescribed.

The graphic record of each man's performance before and after smoking follows. Notice that in Test C where the broken line (after smoking) usually run above the solid line (before smoking) there was *no smoking* in the experiment—merely a wait of 30 minutes. This indicates that from the conditions of the experiment it would be fair to assume that, except for the smoking, the broken line would always be above the solid line. The last chart gives the group averages before and after smoking.

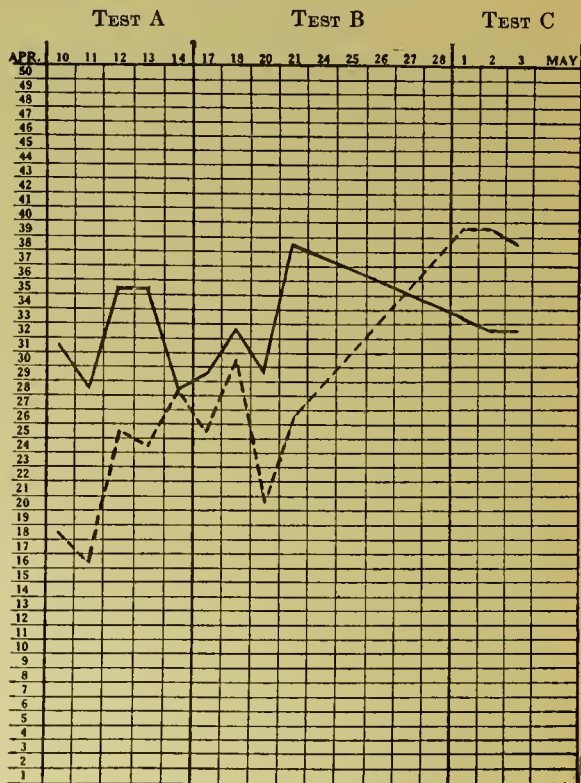
MR. A. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING



MR. B. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING

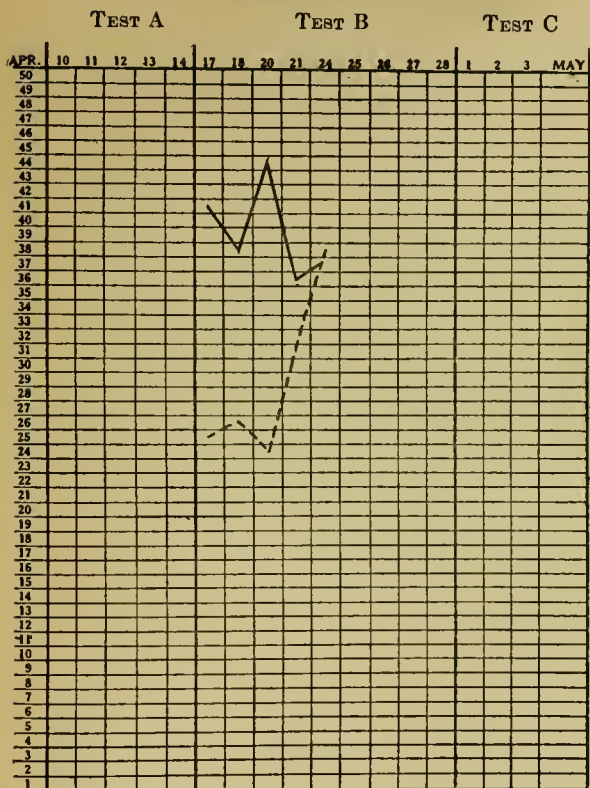


MR. C. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING



————— BEFORE SMOKING - - - - - AFTER SMOKING

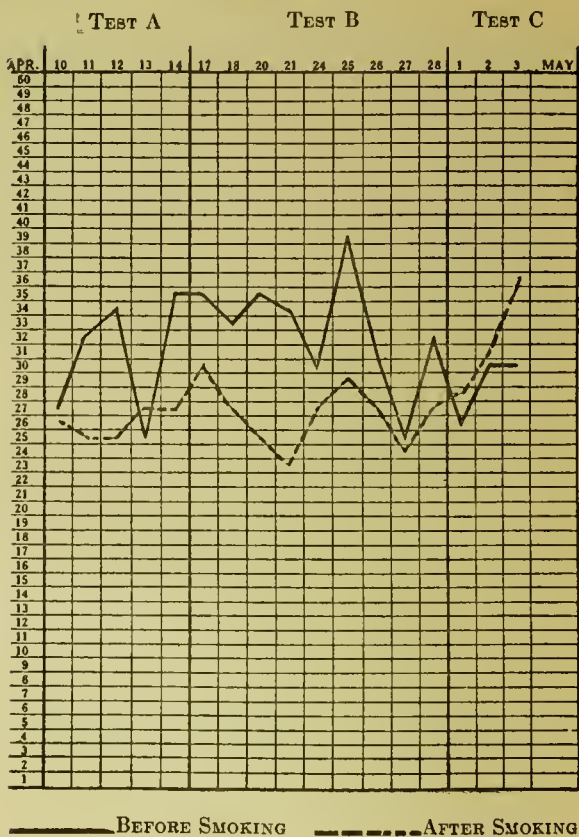
MR. D. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING



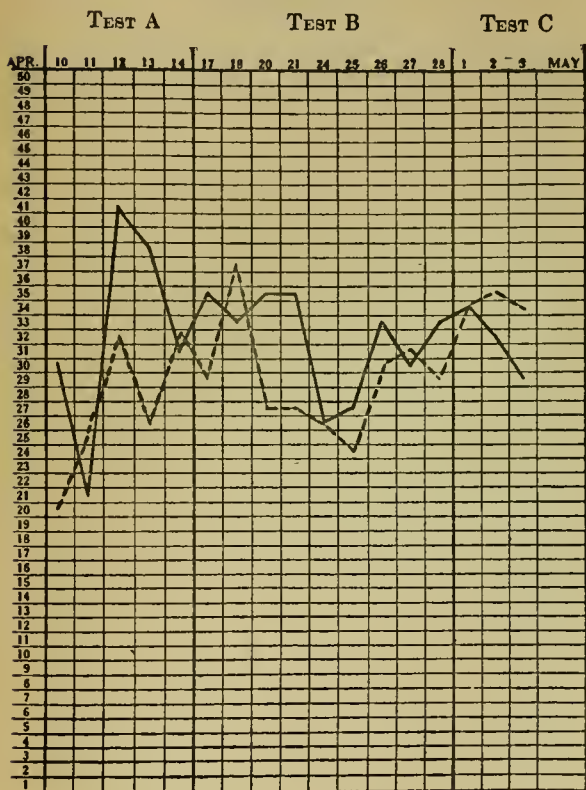
BEFORE SMOKING

AFTER SMOKING

MR. M. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING

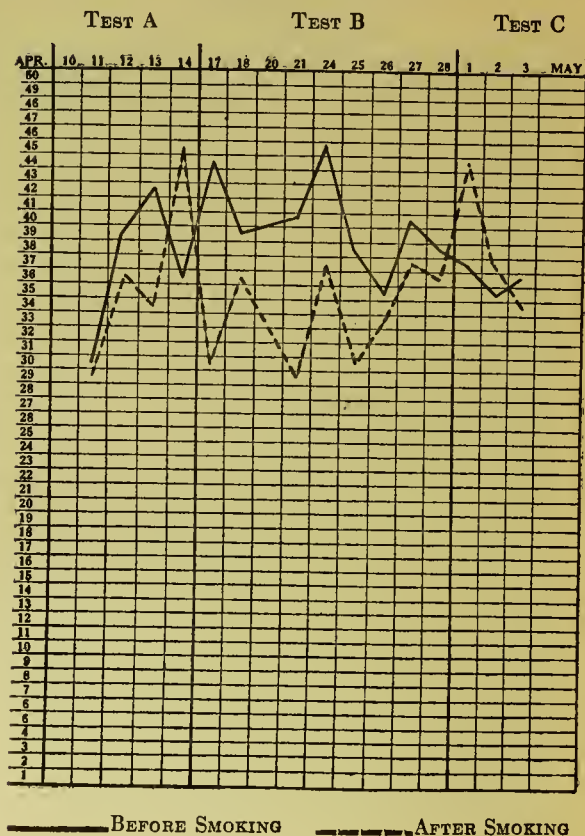


MR. P. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING

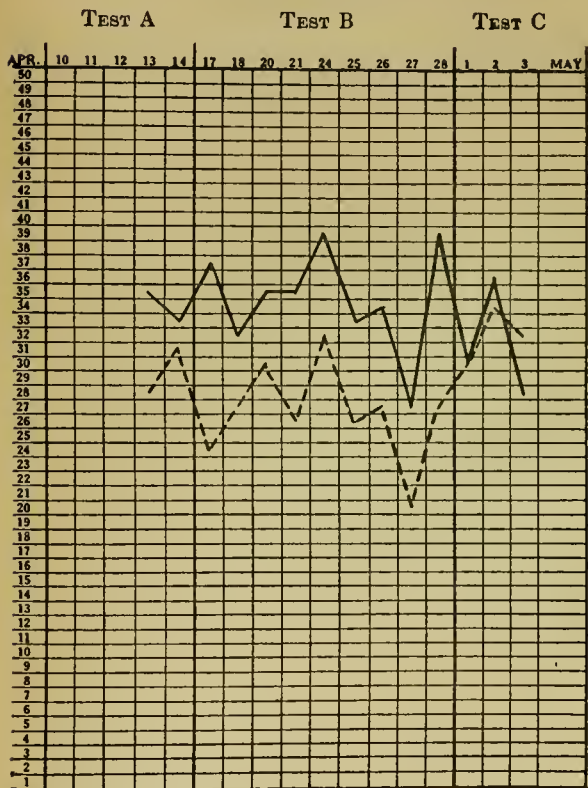


————— BEFORE SMOKING - - - - - AFTER SMOKING

MR. R. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING



MR. S. CHART SHOWING TOTALS BEFORE AND AFTER SMOKING



————— BEFORE SMOKING - - - - - AFTER SMOKING

CHART SHOWING GROUP AVERAGES BEFORE AND AFTER SMOKING

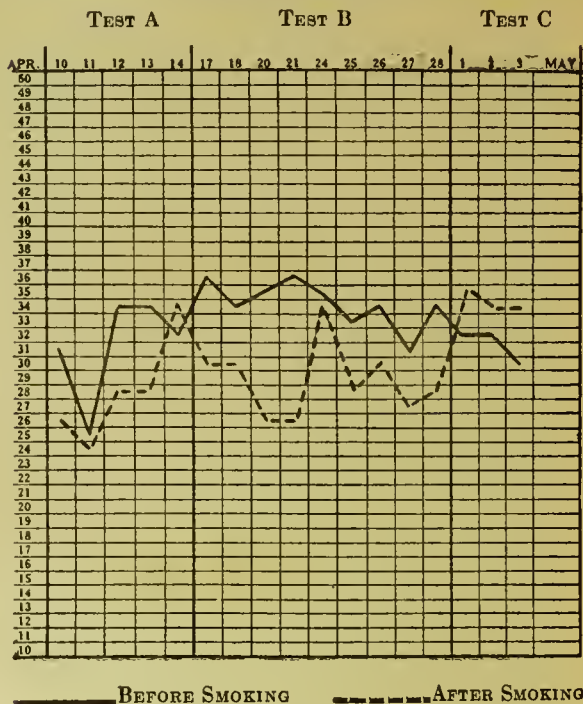


Chart shows result of 113 individual experiments. Experiment consists of throwing ten baseballs at a target before smoking and after smoking. 1,130 baseballs thrown before smoking and 1,130 thrown after smoking.

ACCURACY IN BASEBALL PITCHING 141

COMPARISON OF AVERAGES BETWEEN SMOKERS AND NON-SMOKERS

TEST A

SMOKERS			NON-SMOKERS		
	Before Smoking	After Smoking		Before Smoking	After Smoking
Mr. M.	30.60	26.00	Mr. A.	31.20	27.00
Mr. P.	32.20	27.20	Mr. B.	29.20	28.20
Mr. R.	36.50	26.00	Mr. C.	31.40	24.20
Mr. S.	34.00	29.50			
Averages	33.30	29.68		30.60	26.47

You will notice that the smokers have a higher average both before and after smoking, which is not an indication, however, that it is due to the fact that they are smokers. You will also notice that the average is a little lower after smoking for the non-smokers than for the smokers, probably because they were affected more by the smoking, yet the difference is so slight that we can say that both smokers and non-smokers are affected to the same degree, a conclusion also reached by Dowling. In addition, the smokers are rated as better ball players, which has some bearing on the score averages.

The average of the smokers is lower after smoking by 3.62 points, and the average of the non-smokers is lower by 4.13 points for this test. This is a very significant fact and thus far it seems as if the smoking positively did affect the throwing of these men.

The above averages are the results of thirty-

one individual experiments during which 310 baseballs were thrown at the target, both before and after smoking.

TEST B					
SMOKERS			NON-SMOKERS		
	Before Smoking	After Smoking		Before Smoking	After Smoking
Mr. M.	32.66	26.55	Mr. A.	32.66	30.33
Mr. P.	31.50	29.25	Mr. B.	32.44	27.77
Mr. R.	39.87	33.62	Mr. C.	32.00	25.20
Mr. S.	34.55	26.55	Mr. D.	39.20	28.80
Averages	34.64	28.99		34.04	28.03

The average of the smokers both before and after smoking is higher than that of the non-smokers, as it was in test A. The average of the non-smokers is affected, after smoking, a little more than the smokers' averages.

The average of the smokers is lower after smoking by 5.65 points and that of the non-smokers by 6.01 points. During this test the men smoked two cigars before throwing the second set of ten balls at the target, and the averages both before and after smoking show a wider difference than in test A, during which only one cigar was smoked. This seems to show that the greater amount of tobacco smoked before the tests causes a greater lack of control when pitching.

The above averages are the results of sixty-one individual experiments during which 610 baseballs were thrown both before and after smoking.

ACCURACY IN BASEBALL PITCHING 143

TEST C (Without Smoking)

TEST C (Without Smoking)					
SMOKERS			NON-SMOKERS		
	Before Delay	After Delay		Before Delay	After Delay
Mr. M.	28.66	31.66	Mr. A.	31.00	31.67
Mr. P.	31.66	34.33	Mr. B.	31.66	34.66
Mr. R.	32.67	38.33	Mr. C.	32.33	38.67
Mr. S.	31.33	32.00			
Averages	31.08	34.08		31.66	35.00

During this test there was no smoking. Each of the men would throw ten baseballs at the target, wait about thirty minutes, which is equal to the time taken in smoking a cigar, and then throw ten more baseballs at the target. The averages of the smokers and non-smokers are about the same, but, unlike the other tests in which there was smoking, the averages after the delay were actually increased, probably due to the absence of the effects of smoking.

The above averages are the results of twenty-one individual experiments during which 210 baseballs were thrown at the target and after a delay of 30 minutes 210 more.

GROUP CONCLUSIONS OF TEST A

On April 10, 1916, seven experiments were conducted. Five men made lower scores after smoking one cigar and two men made better scores.

On April 11, 1916, eight experiments were conducted. Five men made lower scores after smoking one cigar, two men made better scores, and one man tied his score.

On April 12, 1916, eight experiments were conducted. All of the men made lower scores after smoking one cigar.

On April 13, 1916, seven experiments were conducted. Six men made better scores before smoking one cigar and one man made a better score after smoking.

On April 14, 1916, seven experiments were conducted. Two men made lower scores after smoking one cigar, four men made better scores after smoking, and one man tied his score.

During the five days that the experiments were conducted eleven men took part. In all thirty-seven scores were made before smoking and the same number after. The number of scores that were bettered after smoking was nine, two tied, and twenty-six made lower scores after smoking.

The group averages for each day show that on four days the average score was lower after smoking than before, and one day the average score was better after smoking than before.

Date	Average Scores Before Smoking	Average Scores After Smoking	Average Loss
4-10-16	30.70	26.14	4.56
4-11-16	24.75	24.12	0.63
4-12-16	34.28	28.42	5.86
4-13-16	34.00	28.14	5.86
4-14-16	32.28	32.84	gain— 0.56

The average score before smoking for the week is 31.20.

The average score after smoking for the week is 27.73.

The average loss after smoking for the week is 3.47.

GROUP CONCLUSIONS OF TEST B

On April 17, 1916, eight experiments were conducted. All of the eight men made lower records after smoking.

On April 18, 1916, eight experiments were conducted. Seven men made lower scores after smoking the two cigars and one man did better.

On April 20, 1916, six experiments were conducted. Five men made lower scores after smoking and one man made a higher score.

On April 21, 1916, eight experiments were conducted. All of the eight men made lower scores after smoking.

On April 24, 1916, seven experiments were conducted. Three men made lower scores after smoking, three men made higher scores after smoking and one man tied his score.

On April 25, 1916, six experiments were conducted. Five men made lower scores after smoking and one man made a higher score.

On April 26, 1916, six experiments were conducted. Five men made lower scores after smoking and one man made a higher score.

On April 27, 1916, six experiments were conducted. Five men made lower scores after smoking and one man made a higher score.

On April 28, 1916, six experiments were conducted. All of the six men made lower scores after smoking.

During the nine days that the experiments were conducted eight men took part. In all sixty-one scores were recorded before smoking and sixty-one after.

Eight scores were higher after smoking.

One score was tied after smoking.

Fifty-two scores were lower after smoking than before.

Date	Average Scores Before Smoking	Average Scores After Smoking	Average Loss
4-17-16	36.25	29.87	6.38
4-18-16	34.00	30.25	3.75
4-20-16	34.66	26.33	8.33
4-21-16	35.87	26.37	9.50
4-24-16	34.70	32.86	1.84
4-25-16	32.50	28.16	3.34
4-26-16	33.50	29.83	3.67
4-27-16	30.83	27.17	3.66
4-28-16	34.17	29.47	4.60

The average score before smoking for the above nine experiments is 34.05.

The average score after smoking for the above nine experiments is 28.92.

The average loss after smoking for the above nine experiments is 5.13.

GROUP CONCLUSIONS OF TEST C

On May 1, 1916, seven experiments were conducted. Five men made better scores following the thirty-minute interval during which there was no smoking, and two men tied their first scores.

On May 2, 1916, seven experiments were conducted. Five men made better scores following the thirty-minute interval during which there

was no smoking, and two men made lower scores.

On May 3, 1916, seven experiments were conducted. Six men made higher scores and one man made a lower score following the thirty minutes during which there was no smoking.

During the three days that the experiments were conducted seven men took part.

In all twenty-one scores were recorded before and after a thirty-minute interval, which time is equivalent to that occupied in smoking a cigar.

Sixteen scores were higher after the 30-minute delay. Three scores were lower following the 30-minute delay. Two scores were tied following the 30-minute delay.

Date	Average Scores Before Thirty Minute Interval	Average Scores After Thirty Minute Interval	Average Gain
5-1-16	32.28	35.14	gain— 2.86
5-2-16	32.43	34.14	gain— 1.71
5-3-16	30.65	34.14	gain— 3.49

The average score before the thirty minute interval is 31.79 for the above three experiments.

The average score following the thirty minute interval is 34.47 for the above three experiments.

The average gain after the thirty minute interval is 2.68 for the above three experiments.

FINAL CONCLUSIONS

In test A, during which one cigar was smoked, the *smokers* showed a loss of eleven per cent in accuracy when pitching a baseball, after smoking.

In test A, during which one cigar was smoked,

the *non-smokers* showed a loss of thirteen per cent in accuracy when pitching a baseball at a target, after smoking.

The *non-smokers* show an increase of two per cent over the *smokers* in loss of accuracy, after smoking.

The average loss in accuracy during test A for both *smokers* and *non-smokers* is twelve per cent, after smoking.

In test B, during which two cigars were smoked, the *smokers* showed a loss of eleven per cent in accuracy when pitching a baseball at a target, after smoking.

The *non-smokers* in test B showed a loss of eighteen per cent in accuracy when pitching, after smoking.

The *non-smokers* show an increase of seven per cent over the *smokers* in loss of accuracy after smoking.

The average loss in accuracy after smoking during test B, for both *smokers* and *non-smokers*, is fourteen and one half per cent.

In test C, during which no cigars were smoked, the *smokers* showed an increase in accuracy of nine per cent after a delay of thirty minutes, equal to the time taken in smoking a cigar.

In test C, the *non-smokers* showed an increase in pitching a baseball accurately, without smoking, of ten per cent.

The *non-smokers* showed a gain of one per cent over the *smokers* in accuracy of pitching.

The average gain in accuracy of pitching during test C, for both *non-smokers* and *smokers*, is nine and one half per cent.

1. The foregoing experiments have proven conclusively that smoking does actually reduce a man's accuracy in pitching a baseball.

2. The smoking of a single cigar will affect a man's accuracy in pitching, and two cigars increase this effect.

3. In tests during which there was no smoking, the men improved in accuracy of pitching.

The individual tables are given in the appendix to enable the interested person to follow the experiments in detail.

APPENDIX TO PART IV

TEST A

MONDAY, APRIL 10, 1916

For this table, see page 130

TEST A

TUESDAY, APRIL 11, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	4	0	2	5	3	5	1	4	4	4	32
Mr. E.	4	4	3	1	3	3	4	3	4	2	31
Mr. P.	3	2	4	3	0	3	0	5	1	0	21
Mr. F. Discontinued											
Mr. A.	1	3	3	3	3	1	1	0	3	5	23
Mr. B.	1	4	3	4	4	2	2	3	5	1	29
Mr. C.	2	2	2	1	4	3	3	4	2	5	28
Mr. R.	1	5	4	1	1	2	5	5	4	2	30
Mr. I.	3	4	2	1	0	3	4	4	0	2	23

The above scores were made before smoking.

The following scores were made after smoking one cigar.

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	5	1	1	1	4	1	3	5	1	3	25
Mr. E.	4	3	3	0	4	3	3	4	2	5	29
Mr. P.	2	3	5	2	2	1	3	1	3	3	25
Mr. F. Discontinued											
Mr. A.	0	3	3	2	1	3	3	2	4	2	23
Mr. B.	0	0	0	3	3	3	3	5	3	1	21
Mr. C.	2	1	1	4	1	4	0	1	0	2	16
Mr. R.	1	3	3	3	5	2	1	4	2	5	29
Mr. I.	3	4	1	4	1	0	1	5	3	3	25

The average score before smoking is

27.12

The average score after smoking is

24.12

There is a decrease after smoking of

3.

TEST A

WEDNESDAY, APRIL 12, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	2	4	4	4	5	5	1	4	4	1	34
Mr. E. Discontinued											
Mr. P.	3	5	4	3	3	4	5	5	4	5	41
Mr. A.	1	3	5	3	2	2	3	4	1	5	29
Mr. B.	2	4	5	3	2	3	4	2	4	3	32
Mr. C.	5	4	5	2	3	5	2	5	3	1	35
Mr. R.	4	4	4	4	3	5	5	3	3	4	39
Mr. I. Discontinued											
Mr. J.	4	4	2	1	4	4	1	3	3	4	30

The above scores were made before smoking.

ACCURACY IN BASEBALL PITCHING 151

The following scores were made after smoking one cigar.

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	1	0	2	2	5	2	0	4	5	4	25
Mr. E.	Discontinued										
Mr. P.	5	4	5	4	4	5	1	1	0	3	32
Mr. A.	4	1	3	4	2	4	2	3	1	2	26
Mr. B.	4	2	1	5	5	2	4	1	1	1	26
Mr. C.	2	2	3	3	1	4	4	2	1	3	25
Mr. R.	4	5	3	2	4	3	4	4	2	5	36
Mr. I.	Discontinued										
Mr. J.	1	3	4	4	1	4	4	4	1	3	29

The average score made before smoking is 34.28

The average score made after smoking is 28.42

There is a decrease after smoking of 5.86

TEST A

THURSDAY, APRIL 13, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	1	2	4	1	3	1	3	5	0	5	25
Mr. P.	4	5	4	4	4	4	3	4	3	3	38
Mr. A.	3	4	2	5	4	0	3	5	5	3	34
Mr. B.	3	4	4	1	4	2	4	3	2	3	30
Mr. C.	3	3	4	5	3	2	4	4	3	4	35
Mr. R.	4	3	4	4	5	3	5	4	5	4	41
Mr. J.	Absent										
Mr. S.	5	2	4	4	4	1	2	5	3	5	35

The above scores were made before smoking

The following scores were made after smoking one cigar.

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	1	3	0	1	2	5	5	2	4	4	27
Mr. P.	5	3	2	1	3	1	5	2	2	2	26
Mr. A.	1	0	3	2	2	1	3	5	2	3	22
Mr. B.	3	4	1	2	3	2	4	2	4	1	26
Mr. C.	3	4	3	3	5	5	3	2	3	3	34
Mr. R.	4	2	5	2	3	5	1	4	4	4	34
Mr. J.	Absent										
Mr. S.	1	3	5	3	3	4	4	1	0	4	28

The average score made before smoking is 34.00

The average score made after smoking is 28.14

There is a decrease after smoking of 5.86

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TEST A—FRIDAY, APRIL 14, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	3	4	5	4	3	2	1	5	5	3	35
Mr. P.	2	4	3	1	3	4	4	4	5	1	31
Mr. A.	5	4	1	5	5	5	3	1	3	3	35
Mr. B.	3	2	4	3	2	2	4	3	2	3	28
Mr. C.	3	3	2	3	1	4	2	4	2	4	28
Mr. R.	3	2	3	3	5	2	5	4	5	4	36
Mr. J.	Absent. Discontinued										
Mr. S.	4	3	4	3	3	4	2	4	2	4	33

The above scores were made before smoking.

The following scores were made after smoking one cigar.

Mr. M.	3	5	1	0	2	5	4	4	2	1	27
Mr. P.	0	2	2	4	5	3	3	5	4	5	33
Mr. A.	5	4	1	5	4	4	2	5	5	1	36
Mr. B.	2	3	4	3	4	4	3	3	2	2	30
Mr. C.	0	0	4	3	3	3	3	5	2	5	28
Mr. R.	4	5	5	4	5	3	4	5	5	5	45
Mr. J.	Absent. Discontinued										
Mr. S.	3	5	3	2	2	3	5	5	1	2	31

The average score made before smoking is

32.28

The average score made after smoking is

32.86

There is an increase after smoking of

0.58

TEST B—MONDAY, APRIL 17, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	3	4	2	1	5	5	4	4	3	4	35
Mr. P.	1	5	3	4	4	3	4	4	3	4	35
Mr. A.	2	4	4	3	4	3	5	3	3	3	34
Mr. B.	4	4	3	4	1	5	5	2	3	4	35
Mr. C.	4	2	4	2	5	2	3	4	1	2	29
Mr. R.	4	5	5	4	4	4	5	5	5	3	44
Mr. S.	4	1	4	5	3	4	4	4	3	5	37
Mr. D.	5	5	5	4	3	4	4	4	3	4	41

The above scores were made before smoking.

The following scores were made after smoking two cigars.

Mr. M.	4	4	2	3	2	1	4	3	2	5	30
Mr. P.	4	2	2	3	1	2	3	4	5	3	29
Mr. A.	3	5	1	4	4	3	2	2	4	1	29
Mr. B.	2	3	0	4	1	5	2	2	3	4	26
Mr. C.	2	1	4	3	1	3	2	2	3	4	25
Mr. R.	4	4	3	3	3	3	4	3	3	1	31
Mr. S.	1	3	3	2	3	4	0	3	2	5	24
Mr. D.	1	4	0	3	4	3	4	1	3	2	25

The average score before smoking is

36.25

The average score after smoking is

27.37

There is a decrease after smoking of

8.88

ACCURACY IN BASEBALL PITCHING 153

TEST B—TUESDAY, APRIL 18, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	1	3	1	2	5	5	3	5	3	5	33
Mr. P.	2	1	4	2	4	4	3	4	5	4	33
Mr. A.	5	2	4	4	3	5	3	1	3	5	35
Mr. B.	2	3	4	2	4	2	5	1	4	3	30
Mr. C.	4	5	3	4	1	4	4	3	1	3	32
Mr. R.	4	5	4	4	4	5	3	3	4	3	39
Mr. S.	1	5	5	3	3	1	3	3	4	4	32
Mr. D.	3	3	3	5	4	4	3	5	5	3	38

The above scores were made before smoking.

The following scores were made after smoking two cigars.

Mr. M.	3	4	3	3	3	2	5	0	3	1	27
Mr. P.	3	4	2	5	3	4	4	5	3	5	38
Mr. A.	0	4	3	0	4	3	4	4	4	3	29
Mr. B.	4	3	1	5	3	3	1	5	3	1	29
Mr. C.	5	3	4	5	3	0	1	3	4	2	30
Mr. R.	5	5	3	5	1	3	5	3	4	2	36
Mr. S.	4	4	1	2	3	2	4	3	2	2	27
Mr. D.	3	3	3	4	1	3	3	3	1	2	26

The average score before smoking is

34.00

The average score after smoking is

30.25

There is a decrease after smoking of

3.75

TEST B—THURSDAY, APRIL 20, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	5	4	2	4	3	3	5	3	5	1	35
Mr. P.	Absent										
Mr. A.	2	2	2	2	4	4	4	4	2	2	28
Mr. B.	5	5	5	4	3	4	2	3	3	3	37
Mr. C.	5	5	1	4	3	5	0	1	0	5	29
Mr. R.	Absent										
Mr. S.	3	2	3	3	3	4	5	3	4	5	35
Mr. D.	5	4	5	5	2	5	4	5	5	4	44

The above scores were made before smoking.

The following scores were made after smoking two cigars.

Mr. M.	3	4	2	1	1	4	5	4	0	1	25
Mr. P.	Absent										
Mr. A.	4	1	4	4	3	5	0	5	1	4	31
Mr. B.	2	5	3	2	0	3	5	3	3	2	28
Mr. C.	3	0	5	1	3	4	1	1	0	2	20
Mr. R.	Absent										
Mr. S.	5	3	2	0	3	5	2	5	2	3	30
Mr. D.	4	3	2	3	1	2	4	0	1	4	24

NOTE.—April 19, Patriots' Day, being a holiday, no experiments were conducted.

The average score before smoking is

34.66

The average score after smoking is

26.33

There is a decrease after smoking of

8.33

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TEST B—FRIDAY, APRIL 21, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	3	2	5	4	2	3	2	5	4	4	34
Mr. P.	3	5	4	4	2	3	4	3	4	3	35
Mr. A.	1	3	5	4	3	2	4	3	5	4	34
Mr. B.	4	1	3	1	5	4	5	4	4	4	35
Mr. C.	4	5	4	4	3	2	5	4	3	4	38
Mr. R.	5	4	4	3	2	4	4	5	5	4	40
Mr. S.	4	4	3	3	5	4	4	2	1	5	35
Mr. D.	3	4	2	5	5	4	4	3	3	3	36

The above scores were made before smoking.

The following scores were made after smoking two cigars.

Mr. M.	5	1	2	0	4	2	3	1	2	3	23
Mr. P.	4	5	1	3	2	2	3	1	4	2	27
Mr. A.	2	1	4	3	0	5	4	1	2	3	25
Mr. B.	4	1	2	1	3	2	4	2	5	0	24
Mr. C.	4	4	3	4	0	1	3	2	3	2	26
Mr. R.	3	4	3	4	2	3	4	1	3	2	29
Mr. S.	3	2	2	3	4	1	5	0	4	2	26
Mr. D.	3	3	4	3	3	2	4	2	3	4	31

The average score before smoking is

35.87

The average score after smoking is

26.37

There is a decrease after smoking of

9.50

TEST B—MONDAY, APRIL 24, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	3	2	4	4	0	3	5	3	5	1	30
Mr. P.	4	3	3	3	1	2	1	3	5	3	26
Mr. A.	5	2	5	5	3	4	2	1	2	5	34
Mr. B.	5	5	1	5	4	2	1	2	4	3	32
Mr. C.	Discontinued										
Mr. R.	4	5	4	5	5	5	5	4	4	4	45
Mr. S.	4	5	4	5	4	3	1	4	4	5	39
Mr. D.	4	4	4	3	4	4	2	4	4	4	37

The above scores were made before smoking.

The following scores were made after smoking two cigars.

Mr. M.	5	2	1	1	3	1	5	1	4	4	27
Mr. P.	4	1	1	4	5	1	2	5	1	2	26
Mr. A.	5	2	4	4	3	4	3	3	5	4	37
Mr. B.	5	1	4	5	3	0	4	4	2	5	33
Mr. C.	Discontinued										
Mr. R.	4	2	4	4	5	3	2	5	3	5	37
Mr. S.	1	3	4	4	3	3	3	4	2	5	32
Mr. D.	3	5	3	3	4	4	4	5	2	5	38

The average score before smoking is

34.70

The average score after smoking is

32.86

There is a decrease after smoking of

1.84

ACCURACY IN BASEBALL PITCHING 155

TEST B

TUESDAY, APRIL 25, 1916

	1	2	3	4	5	6	7	8	9	19	Totals
Mr. M.	4	3	4	4	4	5	3	4	3	5	39
Mr. P.	3	4	1	2	3	3	1	2	3	5	27
Mr. A.	3	3	3	5	4	4	2	2	2	2	30
Mr. B.	3	1	3	3	0	3	5	2	5	3	28
Mr. R.	4	4	3	5	4	2	5	4	4	3	36
Mr. S.	2	4	5	4	3	5	0	3	3	4	33
Mr. D.	Discontinued										

The above scores were made before smoking.

The following scores were made after smoking two cigars.

Mr. M.	3	4	2	4	5	0	3	2	1	5	29
Mr. P.	2	3	3	0	0	4	3	2	5	2	24
Mr. A.	4	1	5	3	1	4	3	5	5	3	34
Mr. B.	1	1	3	4	2	3	2	3	5	2	26
Mr. R.	4	3	1	5	2	5	2	1	3	4	30
Mr. S.	3	5	2	2	2	3	4	2	1	2	26
Mr. D.	Discontinued										

NOTE.—Mr. D. discontinued because of an accident to his ankle.

The average score before smoking is 32.50

The average score after smoking is 28.16

There is a decrease after smoking of 4.34

TEST B

WEDNESDAY, APRIL 26, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	4	2	5	2	1	5	3	1	4	4	31
Mr. P.	5	2	1	4	2	3	4	3	4	5	33
Mr. A.	4	2	3	2	4	1	5	2	4	3	30
Mr. B.	5	4	1	5	4	4	3	4	5	3	38
Mr. R.	5	4	4	4	4	3	2	4	3	2	35
Mr. S.	4	3	4	5	3	1	3	2	5	4	34

The above scores were made before smoking.

The following scores were made after smoking two cigars.

Mr. M.	5	2	1	4	2	3	3	4	1	2	27
Mr. P.	1	3	4	2	3	5	3	2	4	3	30
Mr. A.	5	3	4	1	2	3	2	4	4	3	31
Mr. B.	2	4	4	3	2	1	3	4	5	3	31
Mr. R.	4	4	3	3	4	4	5	2	1	3	33
Mr. S.	3	3	2	4	2	1	4	3	3	2	27

The average score before smoking is 33.50

The average score after smoking is 29.83

There is a decrease after smoking of 3.67

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TEST B

THURSDAY, APRIL 27, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	2	3	5	2	2	4	1	3	3	0	25
Mr. P.	4	3	2	1	5	5	2	4	1	3	30
Mr. A.	4	3	3	5	4	3	4	3	5	2	36
Mr. B.	5	1	1	1	4	1	5	4	3	2	27
Mr. R.	4	3	5	4	5	4	4	4	5	2	40
Mr. S.	0	3	5	3	4	2	5	2	1	2	27

The above scores were made before smoking.

The following scores were made after smoking two cigars.

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	4	1	3	2	5	0	2	3	2	2	24
Mr. P.	3	3	3	2	4	5	3	4	1	3	31
Mr. A.	3	3	4	3	5	2	1	2	4	0	27
Mr. B.	4	3	3	5	2	0	0	1	3	3	24
Mr. R.	4	3	5	4	3	3	4	4	4	3	37
Mr. S.	1	3	1	3	2	1	0	3	4	2	20

The average score before smoking is

30.83

The average score after smoking is

27.17

There is a decrease after smoking of

3.66

TEST B

FRIDAY, APRIL 28, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	2	3	2	5	4	2	1	4	5	4	32
Mr. P.	3	4	4	1	2	5	4	2	4	4	33
Mr. A.	3	4	5	0	5	4	4	3	2	3	33
Mr. B.	4	2	1	3	2	5	0	5	4	4	30
Mr. R.	5	4	4	3	2	4	3	4	5	4	36
Mr. S.	4	3	4	5	4	3	4	5	2	5	39

The above scores were made before smoking.

The following scores were made after smoking two cigars.

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	1	5	4	3	2	4	2	2	2	3	27
Mr. P.	5	2	4	1	3	4	2	5	0	3	29
Mr. A.	5	4	4	3	2	1	4	2	3	2	30
Mr. B.	2	5	3	4	2	1	4	3	3	2	29
Mr. R.	4	4	3	4	5	5	2	2	3	4	38
Mr. S.	4	4	3	2	5	1	0	5	2	1	27

The average score before smoking is

34.17

The average score after smoking is

29.47

There is a decrease after smoking of

4.60

ACCURACY IN BASEBALL PITCHING 157

TEST C

MONDAY, MAY 1, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	1	3	3	3	3	4	0	4	4	1	26
Mr. P.	5	4	3	2	4	1	2	5	4	4	34
Mr. A.	4	5	2	3	3	3	4	4	1	4	33
Mr. B.	4	4	2	2	2	5	2	5	3	4	33
Mr. C.	5	4	3	2	2	3	4	4	3	3	33
Mr. R.	5	5	5	2	3	4	5	3	2	3	37
Mr. S.	3	5	2	2	5	3	2	3	2	3	30

The above scores were made upon arrival at the gymnasium.

The following scores were made thirty minutes after the above scores. No smoking in these experiments.

Mr. M.	3	4	5	0	5	1	2	1	5	2	28
Mr. R.	4	2	5	5	3	5	0	4	1	5	34
Mr. A.	4	5	0	5	4	5	2	3	4	2	34
Mr. B.	5	3	0	4	5	4	5	2	5	4	37
Mr. C.	4	4	2	3	5	5	1	5	4	4	39
Mr. R.	4	5	3	5	4	4	5	4	5	5	44
Mr. S.	4	5	4	4	1	2	3	2	2	3	30

The average score following 30 minutes' delay is 35.14

The average score before the 30 minutes' delay is 32.28

There is an increase after the delay of 2.86

TEST C

TUESDAY, MAY 2, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	2	4	5	1	3	4	3	2	1	5	30
Mr. P.	1	5	5	4	2	3	5	4	1	2	32
Mr. A.	4	2	2	3	4	1	3	2	5	4	30
Mr. B.	2	4	0	5	5	4	2	2	4	5	33
Mr. C.	3	4	4	2	3	1	5	5	3	2	32
Mr. R.	4	4	3	4	5	1	3	4	4	3	35
Mr. S.	3	4	4	3	3	5	2	5	4	3	36

The above scores were made upon arrival at the gymnasium.

The following scores were made thirty minutes after the above scores. No smoking in these experiments.

Mr. M.	4	1	3	2	4	4	2	1	5	5	31
Mr. P.	3	4	4	3	4	3	2	5	5	2	35
Mr. A.	4	4	3	5	4	0	1	2	3	2	28
Mr. B.	4	1	2	4	5	4	5	3	3	3	35
Mr. C.	4	5	4	3	3	3	4	5	4	4	39
Mr. R.	5	5	1	5	4	3	2	4	5	3	37
Mr. S.	4	3	4	2	1	4	4	3	4	5	34

The average following the delay is 34.14

The average score before the delay is 32.43

There is an increase after the delay of 1.71

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TEST C

WEDNESDAY, MAY 3, 1916

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	3	1	5	2	1	4	4	3	4	3	30
Mr. P.	3	2	5	4	2	1	3	3	4	2	29
Mr. A.	2	5	5	1	4	3	2	0	4	4	30
Mr. B.	3	0	5	2	4	3	1	2	4	5	29
Mr. C.	3	4	2	1	4	3	3	5	5	2	32
Mr. R.	4	3	2	5	3	4	4	3	4	4	36
Mr. S.	4	1	1	5	2	2	5	2	3	3	28

The above scores were made upon arrival at the gymnasium.

The following scores were made thirty minutes after the above scores. No smoking in these experiments.

	1	2	3	4	5	6	7	8	9	10	Totals
Mr. M.	4	4	5	2	4	3	4	4	3	3	36
Mr. P.	4	4	1	3	4	5	2	2	5	4	34
Mr. A.	3	4	1	5	0	5	4	4	3	4	33
Mr. B.	3	1	4	4	3	4	4	2	4	3	32
Mr. C.	4	4	5	3	4	2	4	5	5	2	38
Mr. R.	5	5	1	3	5	4	2	2	3	4	34
Mr. S.	1	4	3	1	4	4	3	4	4	4	32

The average score following the delay is 34.14

The average score before the delay is 30.65

There is an increase after the delay of 3.49

For individual record of Mr. M., see page 130.

INDIVIDUAL RECORD OF MR. E., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-10-16	A	29	33		4
4-11-16	A	31	29	2	

Mr. E. discontinued the experiments at this point, claiming that the effect produced by the smoking of the cigars caused a continual headache, which on the third evening had not gone away. This man was an abstainer from the use of tobacco in any form and it is regretted that he could not continue, in order that his records might be compared with those of smokers.

ACCURACY IN BASEBALL PITCHING 159

INDIVIDUAL RECORD OF MR. P., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-10-16	A	30	20	10	
4-11-16	A	21	25		4
4-12-16	A	41	32	9	
4-13-16	A	38	26	12	
4-14-16	A	31	33		2
4-17-16	B	35	29	6	
4-18-16	B	33	38		5
4-20-16	B	Absent			
4-21-16	B	35	27	8	
4-24-16	B	26	26		
5-25-16	B	27	24	3	
4-26-16	B	33	30	3	
4-27-16	B	30	31		1
4-28-16	B	33	29	4	

		Before Delay	After Delay	
5- 1-16	C	34	34	
5- 2-16	C	32	35	3
5- 3-16	C	29	34	5

Mr. P. is a catcher and has played semi-professional baseball. At present he is catcher of a college varsity team. He smokes cigarettes regularly, consuming from one to two packages daily. He, too, was requested to stop smoking cigarettes during these experiments and use only the cigars prescribed.

INDIVIDUAL RECORD OF MR. F., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-1-16	A	36	30	6	

Mr. F. discontinued the experiments after the first one, because the effects of the cigar made him very sick. He became quite pale, showed

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signs of dizziness and hurried home to bed. The next day he complained of a sick headache. This man had never smoked a cigar before this one during his whole life, and saved the stub as a reminder. While in high school he pitched for the team.

INDIVIDUAL RECORD OF MR. A., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-10-16	A	35	28	7	
4-11-16	A	23	23		
4-12-16	A	29	26	3	
4-13-16	A	34	22	12	
4-14-16	A	35	36		1
4-17-16	B	34	29	5	
4-18-16	B	35	29	6	
4-20-16	B	28	31		3
4-21-16	B	34	25	9	
4-24-16	B	34	37		3
4-25-16	B	30	34		4
4-26-16	B	30	31		1
4-27-16	B	36	27	9	
4-28-16	B	33	30	3	
		Before Delay	After Delay		
5- 1-16	C	33	34		1
5- 2-16	C	30	28	2	
5- 3-16	C	30	33		3

Mr. A. is a ball player with ability as an outfielder, and at present is playing on the college varsity baseball team. Mr. A. is not a user of tobacco in any form, and will therefore be termed a non-smoker in making comparisons.

ACCURACY IN BASEBALL PITCHING 161

INDIVIDUAL RECORD OF MR. B., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-10-16	A	27	28		1
4-11-16	A	29	21	8	
4-12-16	A	32	26	6	
4-13-16	A	30	26	4	
4-14-16	A	28	30		2
4-17-16	B	35	26	9	
4-18-16	B	30	29	1	
4-20-16	B	37	28	9	
4-21-16	B	35	24	11	
4-24-16	B	32	33		1
4-25-16	B	28	26	2	
4-26-16	B	38	31	7	
4-27-16	B	27	24	3	
4-28-16	B	30	29	1	
5- 1-16	C	33	37		4
5- 2-16	C	33	35		2
5- 3-16	C	29	32		3

Mr. B. is a non-smoker and it was with considerable persuasion that he finally went through with the experiments without discontinuing. At present he plays baseball three times a week on a college class team and has but average ability.

INDIVIDUAL RECORD OF MR. C., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-11-16	A	31	18	13	
4-12-16	A	28	16	12	
4-13-16	A	35	25	10	
4-14-16	A	35	34	1	
4-15-16	A	28	28		
4-17-16	B	29	25	4	
4-18-16	B	32	30	2	
4-20-16	B	29	20	9	
4-21-16	B	38	26	12	

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Date	Test	Before Smoking Before Delay	After Smoking After Delay	Loss	Gain
5- 1-16	C	33	39	6	
5- 2-16	C	32	39	7	
5- 3-16	C	32	38	6	

Mr. C. has been pitching college baseball four years and has had considerable experience in semi-professional circles. At present he works out every day with the squad. Last year he smoked cigarettes moderately, but has not smoked any since last June (1914). He claimed they interfered with his digestion and ceased using them. For purposes of comparison Mr. C. will be termed a non-smoker.

INDIVIDUAL RECORD OF MR. R., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-11-16	A	30	29	1	
4-12-16	A	39	36	3	
4-13-16	A	41	34	7	
4-14-16	A	36	45		9
4-17-16	B	44	31	13	
4-18-16	B	39	36	3	
4-20-16	B	Absent			
4-21-16	B		29	11	
4-24-16	B		37	8	
4-25-16	B		30	8	
4-26-16	B	35	33	2	
4-27-16	B	40	37	3	
4-28-16	B	38	36	2	
5- 1-16	C	37	44	7	
5- 2-16	C	35	37	2	
5- 3-16	C	36	34	2	

Mr. R. habitually chews tobacco and smokes a pipe moderately; with his system thus inoculated with the effects of tobacco, he will be termed a smoker. He has played third base on a college team and has considerable experience in playing professional baseball. At present he works out with the college squad every day.

INDIVIDUAL RECORD OF MR. I., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-11-16	A	23	25		2

It seems as though the smoking of strong cigars does not agree with abstainers from the weed. Such was the case with Mr. I., who claimed that he could not stand the effects of the tobacco. He said it caused a very undesirable feeling in the region of the stomach. Had he not experienced this feeling, he would have continued with the experiments.

INDIVIDUAL RECORD OF MR. J., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-12-16	A	30	29	1	

Mr. J. is an abstainer from the use of tobacco in any form, and it was hoped that he would continue with the experiments, but like some of the other men that dropped out, the effects of the smoke were too much for him. Headache, stomach-ache and other unpleasant feelings fol-

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lowed the first cigar and he could not be persuaded to take another chance.

INDIVIDUAL RECORD OF MR. S., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-13-16	A	35	28	7	
4-14-16	A	33	31	2	
4-17-16	B	37	24	13	
4-18-16	B	32	27	5	
4-20-16	B	35	30	5	
4-21-16	B	35	26	9	
4-24-16	B	39	32	7	
4-25-16	B	33	26	7	
4-26-16	B	34	27	7	
4-27-16	B	27	20	7	
4-28-16	B	39	27	12	
5- 1-16	C	30	30		
5- 2-16	C	36	34	2	
5- 3-16	C	28	32		4

Mr. S. smokes cigars and a pipe regularly and is therefore termed a smoker. He is a ball player of average ability and has played first base. At present he plays baseball three days a week with a class team.

INDIVIDUAL RECORD OF MR. D., GIVING TOTALS ONLY

Date	Test	Before Smoking	After Smoking	Loss	Gain
4-17-16	B	41	25	16	
4-18-16	B	38	26	12	
4-20-16	B	44	24	20	
4-21-16	B	36	31	5	
4-24-16	B	37	38		1

Mr. D. discontinued at this point because of an accident to his ankle. He did not use tobacco in any form and is therefore termed a non-

smoker. His ability as a ball player is not above the ordinary, yet it was good enough for him to make the class team as a pitcher.

INDIVIDUAL RECORD OF MR. D. GIVING AVERAGES ONLY

During test B (5 experiments) Mr. D. made an average score of 39.20 before smoking, out of a possible 50.

During test B (5 experiments) Mr. D. made an average score of 28.80 after smoking two cigars, out of a possible 50.

During test B (5 experiments) Mr. D. made a lower average after smoking, by 10.40 points.

INDIVIDUAL RECORD OF MR. M. GIVING AVERAGES ONLY

During test A (5 experiments) Mr. M. made an average score before smoking of 30.60 out of a possible 50 points.

During test A (5 experiments) Mr. M. made an average score after smoking one cigar of 26.00 out of a possible 50.

During test A (5 experiments) Mr. M. lowered his average after smoking by 4.60 points, probably due to the effects of smoking.

During test B (9 experiments) Mr. M. made an average score before smoking of 32.66 out of a possible 50.

During test B (9 experiments) Mr. M. made an average score after smoking two cigars of 26.55 out of a possible 50.

During test B (9 experiments) Mr. M. made a lower average after smoking by 6.11 points.

During test C (3 experiments) Mr. M. made an average score before an interval of 30 minutes, which is equal to the time occupied in smoking a cigar, of 28.66.

During test C (3 experiments) Mr. M. made an average score after the 30-minute delay of 31.66.

During test C (three experiments) Mr. M. made a higher average after the delay by 3.00 points. No cigars were smoked in this test and probably the increase in score after the delay was due to the absence of the effects of smoking.

INDIVIDUAL RECORD OF MR. P. GIVING AVERAGES ONLY

During test A (5 experiments) Mr. P. made an average score before smoking of 32.20 out of a possible 50.

During test A (5 experiments) Mr. P. made an average score after smoking one cigar of 27.20 out of a possible 50.

During test A (5 experiments) Mr. P. made a lower average after smoking by 5.00 points.

During test B (8 experiments) Mr. P. made

an average score before smoking of 31.50 out of 50.

During test B (8 experiments) Mr. P. made an average score after smoking two cigars of 29.25 out of a possible 50.

During test B (8 experiments) Mr. P. made a lower average after smoking by 2.25 points.

During test C (3 experiments) Mr. P. made an average score before an interval of 30 minutes, which is equal to the time taken to smoke a cigar, of 31.66.

During test C (3 experiments) Mr. P. made an average score after the 30-minute delay of 34.33.

During test C (3 experiments) Mr. P. made a higher average after the delay by 2.67 points.

INDIVIDUAL RECORD OF MR. A. GIVING AVERAGES ONLY

During test A (5 experiments) Mr. A. made an average score of 31.20 before smoking, out of a possible 50.

During test A (5 experiments) Mr. A. made an average score of 27.00 after smoking one cigar, out of a possible 50.

During test A (5 experiments) Mr. A. made a lower average after smoking by 4.20 points.

During test B (9 experiments) Mr. A. made

an average score of 32.66 before smoking, out of a possible 50.

During test B (9 experiments) Mr. A. made an average score of 30.33 after smoking two cigars, out of a possible 50.

During test B (9 experiments) Mr. A. made a lower average after smoking by 2.33 points.

During test C (3 experiments) Mr. A. made an average score before an interval of 30 minutes, which is equal to the time taken in smoking a cigar, of 31.00.

During test C (3 experiments) Mr. A. made an average score after the 30-minute delay of 31.67 points.

During test C (3 experiments) Mr. A. made a higher average after the delay of 0.67 points.

No smoking during test C.

INDIVIDUAL RECORD OF MR. B. GIVING AVERAGES ONLY

During test A (5 experiments) Mr. B. made an average score of 29.20 before smoking, out of a possible 50.

During test A (5 experiments) Mr. B. made an average score of 28.20 after smoking one cigar, out of a possible 50.

During test A (5 experiments) Mr. B. made a lower average after smoking by 1.00 point.

During test B (9 experiments) Mr. B. made

an average score of 32.44 before smoking, out of a possible 50.

During test B (9 experiments) Mr. B. made an average score of 27.77, after smoking two cigars out of a possible 50.

During test B (9 experiments) Mr. B. made a lower average after smoking by 4.67 points.

During test C (3 experiments) Mr. B. made an average score, before interval of 30 minutes, which is equal to the time taken in smoking a cigar, of 31.66.

During test C (3 experiments) Mr. B. made an average score after the 30-minute delay of 34.66 points.

During test C (3 experiments) Mr. B. made a higher average after the delay of 4.67 points.

This increase following the delay was probably due to the absence of the effects of smoking.

INDIVIDUAL RECORD OF MR. C. GIVING AVERAGES ONLY

During test A (5 experiments) Mr. C. made an average score of 31.40 before smoking, out of a possible 50.

During test A (5 experiments) Mr. C. made an average score of 24.20 after smoking one cigar, out of a possible 50.

During test A (5 experiments) Mr. C. made a lower average after smoking by 7.20 points.

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During test B (4 experiments) Mr. C. made an average score of 32.00 before smoking, out of a possible 50.

During test B (4 experiments) Mr. C. made an average score of 25.20, after smoking two cigars, out of a possible 50.

During test B (4 experiments) Mr. C. made a lower average after smoking by 6.80 points.

During test C (3 experiments) Mr. C. made an average score, before an interval of 30 minutes, which is equal to the time taken in smoking a cigar, of 32.33.

During test C (3 experiments) Mr. C. made an average score after the 30-minute delay of 38.67 points.

During test C (3 experiments) Mr. C. made a higher average after the delay by 6.34 points.

Thus far the conclusions seem to indicate that the smoking has some effect on the scores produced.

INDIVIDUAL RECORD OF MR. R. GIVING AVERAGES ONLY

During test A (4 experiments) Mr. R. made an average score of 36.50 before smoking, out of a possible 50.

During test A (4 experiments) Mr. R. made an average score of 36.00 after smoking one cigar, out of a possible 50.

During test A (4 experiments) Mr. R. made a lower average after smoking by 0.50 points.

During test B (8 experiments) Mr. R. made an average score of 39.87 before smoking, out of a possible 50.

During test B (8 experiments) Mr. R. made an average score of 33.62 after smoking two cigars, out of a possible 50.

During test B (8 experiments) Mr. R. made a lower average after smoking by 6.25 points.

During test C (3 experiments) Mr. R. made an average score before an interval of 30 minutes, which is equal to the time taken in smoking a cigar, of 32.67 points.

During test C (3 experiments) Mr. R. made an average score after the 30-minute delay of 38.33 points.

During test C (3 experiments) Mr. R. made a higher average after the delay by 5.66 points.

INDIVIDUAL RECORDS OF MR. S. GIVING AVERAGES ONLY

During test A (2 experiments) Mr. S. made an average score of 34.00 before smoking, out of a possible 50.

During test A (2 experiments) Mr. S. made an average score of 29.50 after smoking one cigar, out of a possible 50.

During test A (2 experiments) Mr. S. made a lower average after smoking by 4.50 points.

During test B (9 experiments) Mr. S. made an average score of 34.55 before smoking, out of a possible 50.

During test B (9 experiments) Mr. S. made an average score of 26.55 after smoking two cigars, out of a possible 50.

During test B (9 experiments) Mr. S. made a lower average after smoking by 8.00 points.

During test C (3 experiments) Mr. S. made an average score before an interval of 30 minutes, which is equal to the time taken in smoking a cigar, of 31.33 points.

During test C (3 experiments) Mr. S. made an average score after the delay of 32.00 points.

During test C (3 experiments) Mr. S. made a higher average after the delay by 0.67 points.

Smokers and non-smokers alike have made lower scores after smoking than before and have increased their scores after the 30-minute delay experiments in which there was no smoking.

PART V

GENERAL SUMMARY

V

GENERAL SUMMARY

It is unnecessary to repeat here the definite conclusions reached by each study. The experimenters have returned results remarkable for their uniformity and general consistency, showing that smoking raises the heart rate and blood pressure, that it markedly delays the return of the heart rate to normal after exercise and that it impairs the neuro-muscular control as indicated by delicate finger exercises and gross muscular coordinations. We have repeatedly stated that these results are preliminary and tentative. The results seem hardly believable. On the other hand we are forced to accept them. There is no escape from the firm, steady, scientific insistence of the figures. If these results are true and accurate, it is high time that our young men be aware of the truth. If such results are produced on healthy vigorous young men in prime condition by *moderate* smoking, what is the effect of the wide-spread use of tobacco upon the manhood of our land?

The significance of these results should not be

lightly tossed aside. An increased heart rate of only 5 beats per minute means that a man's heart does 2074 kilogram-meters (approximately 15,000 foot pounds) more work per day. In fifty years this means 272,471,000 foot pounds of *unnecessary* work. Does that mean, other things being equal, five years less life? Does it mean less margin of safety, less recuperative power, more danger in case of extreme need, in the crises of disease or accident? But if the blood pressure is also raised, even these figures do not represent the whole truth, for the unnecessary work of the heart is even greater. What connection is there between this increasing pressure and arteriosclerosis? Can smoking be one of the great causes of this increasing malady among our middle-aged business men?

More significant than the actual heart rate is the reduced nervous control of the heart. We know the "smoker's heart" of the physician's clinic, but here is definite evidence of the exact effect of minute amounts of smoking. Failure to return to normal after exercise within a reasonable time is sufficient reason for denying athletics and heavy exercise to a would-be athlete. A strong, slow, regularly beating heart which returns quickly to normal after moderate exercise is taken by athletic trainers as one of the surest indications of condition and physical fit-

ness. Here is an influence which quickly and definitely upsets this condition, even in those known to be in prime athletic trim. Athletic trainers have long refused to permit men in training to smoke. They knew clinically that it was bad. Evidently they are eminently justified in their position. One does not mistreat the delicate mainspring of an expensive watch. How much more foolish to subject one's heart to any unnecessary harmful influence. The effect upon neuro-muscular control again emphasizes the trainers' clinical experience. What about the army of skilled mechanics, artisans working on delicate tasks, and surgeons with life and death in their hands? To all of these, clear eyes, steady nerves, and muscles capable of accurate response are absolute essentials. These do not go with smoking. If the neuro-muscular control is affected, what about fatigue? These studies throw no definite light upon that question. It should be definitely studied at the earliest possible opportunity.

A remarkable result of these studies is the apparent indication that the body does not become habituated or immune to these effects. Is this true? Non-smokers showed but little more bad effects in these studies than the smokers. But is it possible that our smokers were really too moderate smokers to become immune? This must

be determined. Or does the business man who is a heavy smoker really suffer tremendously, without knowing it, in these various ways? In the baseball experiment, the more our men smoked the more marked were the results. Here lies a field for further valuable research on a most vital point.

What are the actual comparative effects on boys, young men, and middle-aged men? Is it possible that boys are badly affected, young men somewhat so, and mature men free? Some would like to think so; some practice that theory. There is little in these studies to comfort them. Nevertheless the facts should be determined.

What are the relative effects of cigarettes, cigars, and pipes? These studies used cigarettes but very little, and the results were not conclusive. It would be well if definite information could be secured.

Does smoking have definite effects upon mental and psychic processes? The neuro-muscular apparatus is one machine. It is hardly likely that one side of it is so definitely affected without some effects at least on the other side. Definite experiments ought to attack this phase of the problem.

It is evident that a mere beginning has been made upon this tremendous problem. The surface has merely been scratched. Even the work

already done should be repeated by other observers and the results checked. We are dealing with a deep-rooted human habit. Facts are needed in discussing it, not theories, sentiments, or prejudices. If smoking is as definitely harmful as these studies have indicated it to be, we cannot establish the fact soon enough. If smoking is not harmful but beneficial, it ought to be possible to prove it. We have presented this work in the hope that it may stimulate others to the collection of definite facts along these lines.

BIBLIOGRAPHY

The following bibliography does not presume to be at all complete. It is here presented in the hope that it may be helpful. As will be noted, articles are arranged alphabetically according to authors, and where the author is not given, alphabetically according to the publication in which the article is found.

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